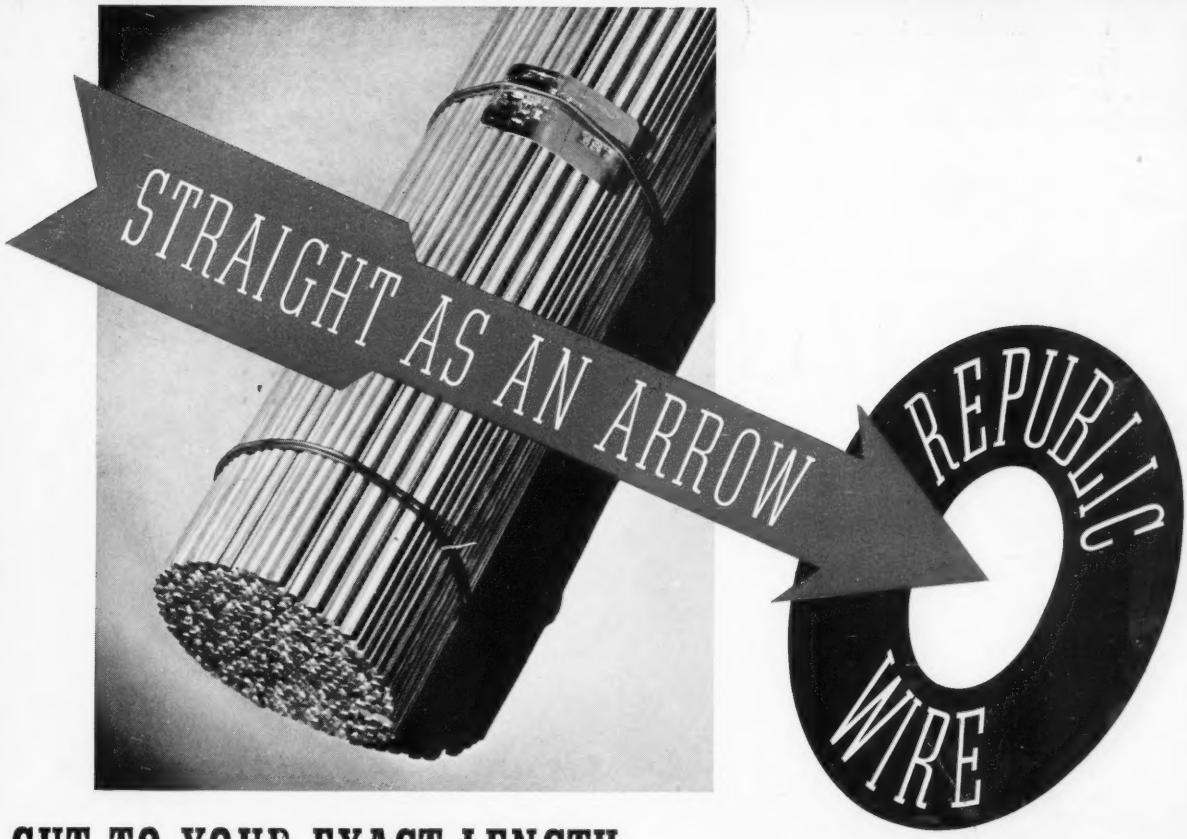
WIRE AND WIRE PRODUCTS

OCTOBER 1938



CUT TO YOUR EXACT LENGTH

● Straight as an arrow . . . cut to the exact length you require . . . and uniformly accurate in analysis, gauge, temper, finish and fabricating qualities . . . you'll find in Republic straightened and cut wire every quality you need to produce better products at higher profit.

Write Department WP, Republic Steel Corporation, 7850 South Chicago Avenue, Chicago, Illinois —or General Offices, Cleveland, Ohio—for quotations on your wire specifications.

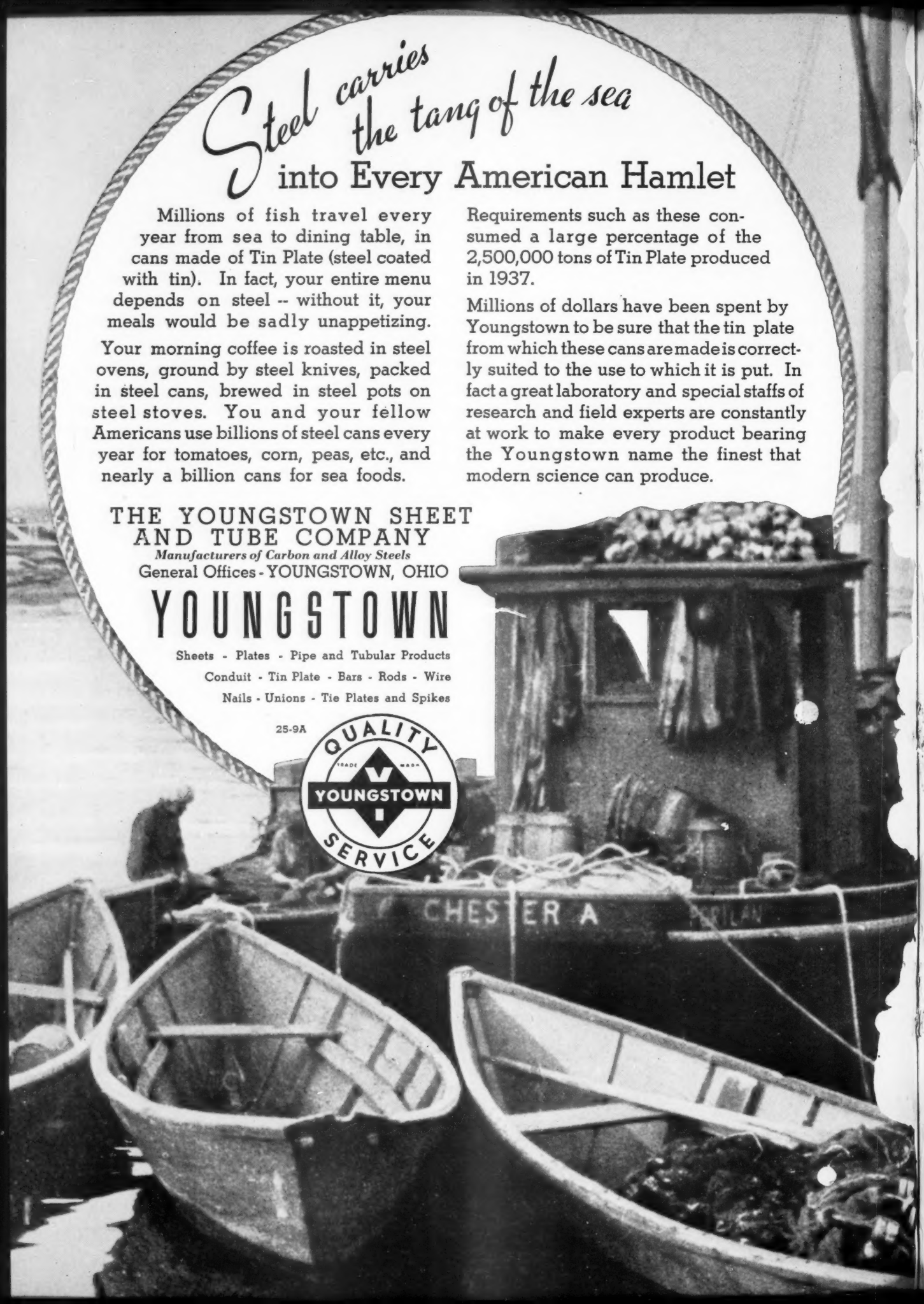
Republic Steel

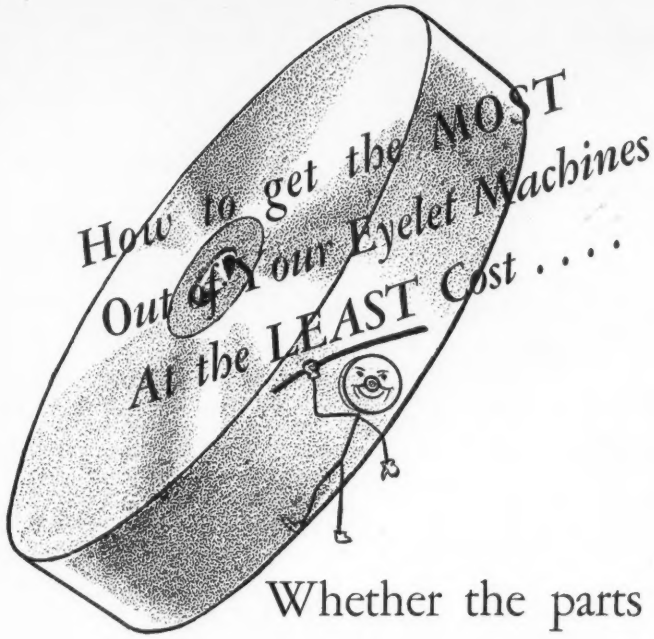
BERGER MANUFACTURING DIVISION
UNION DRAWN STEEL DIVISION
NILES STEEL PRODUCTS DIVISION
TRUSCON STEEL COMPANY
STEEL AND TUBES, INC.

REG. U.S. PAT. OFF. REPUBLIC STEEL

Basic Open-Hearth and Bessemer {Annealed, Regular, Hard Drawn, Sul Coated, Bright, Extra Bright, Copper Coated, Liquor Finish, Galvanized}, Spring Wire, Enduro Stainless Steel Wire, Toncan Iron* Wire, Cold Heading Wire, Wire Rods.*
*Reg. U. S. Pat. Off.

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION


Steel carries the tang of the sea
into Every American Hamlet
Millions of fish travel every year from sea to dining table, in cans made of Tin Plate (steel coated with tin). In fact, your entire menu depends on steel -- without it, your meals would be sadly unappetizing.
Your morning coffee is roasted in steel ovens, ground by steel knives, packed in steel cans, brewed in steel pots on steel stoves. You and your fellow Americans use billions of steel cans every year for tomatoes, corn, peas, etc., and nearly a billion cans for sea foods.
Requirements such as these consumed a large percentage of the 2,500,000 tons of Tin Plate produced in 1937.
Millions of dollars have been spent by Youngstown to be sure that the tin plate from which these cans are made is correctly suited to the use to which it is put. In fact a great laboratory and special staffs of research and field experts are constantly at work to make every product bearing the Youngstown name the finest that modern science can produce.
THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO
YOUNGSTOWN
Sheets - Plates - Pipe and Tubular Products
Conduit - Tin Plate - Bars - Rods - Wire
Nails - Unions - Tie Plates and Spikes
25-9A
QUALITY
YOUNGSTOWN
SERVICE
CHES ER A



Whether the parts you produce on your eyelet machines are for shoes , electric light bulb bases , - - - - lipstick tubes , - - - charged water cartridges , - - - pencil caps , - - - metal radio tubes , - - - - or any one of innumerable other uses - - - - you will find that Carboloy - - eyelet dies give you closer tolerances, better finish, increased production - - - - less scrap - - - - and lower costs.

On high speed, quantity-production eyelet machines—where every minute of down time means a production loss up to 300 pieces, Carboloy eyelet dies pay an unusually high profit dividend.

★ ★ ★ ★

Carboloy Company, Inc., Detroit · Chicago · Cleveland · Newark · Philadelphia · Pittsburgh · Stamford, Conn. · Worcester, Mass. · Plants at: Detroit, Cleveland, Stamford, Conn. · Authorized Distributors: Hartley Wire Die Co., Waterbury, Conn. · Canadian General Electric Co., Ltd., Toronto, Canada.

VISIT CARBOLOY BOOTH 203-207 NATIONAL METAL EXPOSITION DETROIT, MICH. - - - OCT. 17-21, 1938

WIRE & WIRE PRODUCTS, Vol. 13, No. 10, October, 1938, Executive office, 17 East 42nd St., New York, N. Y. Published by the Quinn-Brown Publishing Corp., Richard E. Brown, President; R. S. Spengel, Secretary and Treasurer. Publication office, 13 West Church Street, Washington, N. J. Subscription price: U. S., $5.00; Canada, $5.00 per year, 50 cents per copy; Foreign, $7.50 per year. Entered as second class mail at the Post Office, Washington, N. J., under Act of March, 1879.

Wherever Metal is Ground . . .

NORTON WHEELS

FOR each new development in metals—a Norton abrasive development to meet it. Examples:

The new B-E bond for more effective grinding of high speed tool steels and for more efficient centerless, cylindrical, internal and surface grinding.

Improved cut-off wheels for the production cutting of the new super-hard alloy steels.

Diamond wheels for grinding the cemented carbides.

Norbide abrasive for lapping cemented carbide wire drawing dies.

Improved disc wheels for various types of surface grinding.

Controlled Structure for better duplication of grinding action.

Foundry wheels, billet grinding wheels, roll grinding wheels, mounted points for die work—improvements have been made in each of these, too—keeping them in step with the developments in metals.

It is this continual research and improvement—this keeping pace with metal development—that has made Norton wheels so popular in the metal working industries.

NORTON COMPANY
WORCESTER, MASS.

New York Chicago Detroit
Philadelphia Pittsburgh Hartford
Cleveland Hamilton, Ont.
London Paris Corsico, Italy
Wesseling, Germany

NORTON ABRASIVES

For Increased Production and Better Quality Springs . . . depend on J & L Spring Wire

You step up production and get better quality springs when you standardize on J & L Spring Wire.

Your production is speeded up because J & L Spring Wire lends itself so readily to coiling, crimping, knotting and other forming operations incident to spring making.

You get uniform high quality springs when you use J & L Spring Wire because it has the resilience to provide just the right springiness, and the rugged stamina to hold that springiness indefinitely.

The high quality of J & L Spring Wire results from the use of special steel, exact heat-treating, accurate drawing and careful inspection to assure uniformity to specifications.

J & L Spring Wire is used by hundreds of manufacturers for a wide variety of springs because they know from experience that it gives them better springs at lower cost.

Specify J & L Spring Wire for your requirements. You, too, will find that it will speed up your production and give you better quality springs.

OTHER J & L PRODUCTS

FOR MANUFACTURING: Cold Heading Wire—Forging Steel—Jalcase Steel—Improved Bessemer Screw Steel—Shafting—Tubing—Tin Plate, Black Sheets, and Light Manufacturing Ternes, Tin Mill Sizes—a full line of S.A.E. Carbon Steels.

FOR CONSTRUCTION and MAINTENANCE: Structural Shapes, including Junior Beams and Lightweight Channels—Concrete Reinforcing Bars—Steel Pipe—Structural Shapes and Plates—Steel Piling—Fabricated Structural Work—Nails.

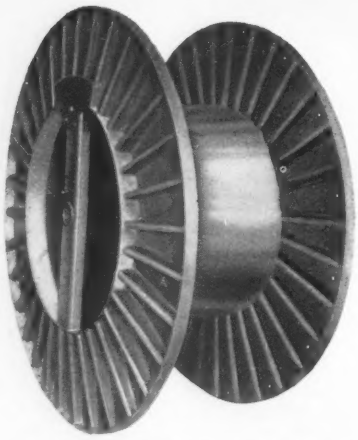
JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

Sales Offices: Atlanta Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Erie Houston Los Angeles Memphis Milwaukee Minneapolis New Orleans New York Philadelphia Pittsburgh Seattle St. Louis San Francisco Tulsa
Warehouses: CHICAGO CINCINNATI DETROIT MEMPHIS NEW ORLEANS NEW YORK (Long Island City)* PITTSBURGH
* Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.
Canadian Representatives: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

J&L STEEL

FOR REEL ECONOMY

STEVENS *LOW-TARE* STEEL SHIPPING REELS



MADE OF HIGH TENSILE STRENGTH STEELS

LOW WEIGHT PLUS LONG LIFE

FOR

ALL I. P. C. E. A. AND SPECIAL

SIZES AND CAPACITIES

STEVENS FLANGED STEEL DRUMS

Reduce reel assembly costs.

Make a stronger reel.

Increase life of reel.

Have given over twelve years service without refinishing or major maintenance.

Made in Low Carbon Steel for Standard Weight and in High Carbon and Alloy Steels for Special Light Weight Drums.

Galvanized — Painted — Plain Finishes

THE STEVENS METAL PRODUCTS CO.

NILES, OHIO

Manufacturers

WIRE

To consider your special needs and problems in wire, all the skill and experience of our metallurgists are at your command. Perhaps—as has happened with many manufacturers—they can point the way to faster work, fewer rejections, lower costs, and a better, more dependable product. As specialists in low-carbon wire we often can furnish a combination of analysis and temper that simplifies fabrication and improves strength in the final product.

Besides special-analysis and copper-bearing steel wire Continental—and only Continental—offers wire of Konik, the patented new steel containing copper, nickel, and chromium. Konik's amazing amenability to carburizing and heat-treatment permits new peaks of hardness, toughness, and resistance to abrasion. Its economies have been proved in four years of use by a variety of manufacturers.

Among the finishes offered by Continental are bright, bright and black annealed; sull-coated; processed; galvanized, including Flame-Sealed; liquored, coppered and tinned in many modifications. Eight shapes are standard, and many specials available. Regular gauges run from No. 34 to ¼ inch. Furnished in coils of suitable sizes, or cut and straightened to specification.

CONTINENTAL STEEL CORPORATION

General Offices: Kokomo, Indiana • Plants at Canton, Kokomo, Indianapolis

CONTINENTAL

STEEL SHEETS AND WIRE PRODUCTS

Wire: Bright Basic, Annealed, *Konik, Special Manufacturers, Galvanized, *Flame-Sealed

Wire Rods, Nails, Staples, Bale Ties, Barbed Wire; Fence Types; Gates and Fittings

Sheets: Black, Galvanized, Special Coated; Roofing and Siding 14 Styles

*Trade Mark Registered, U. S. Patent Office

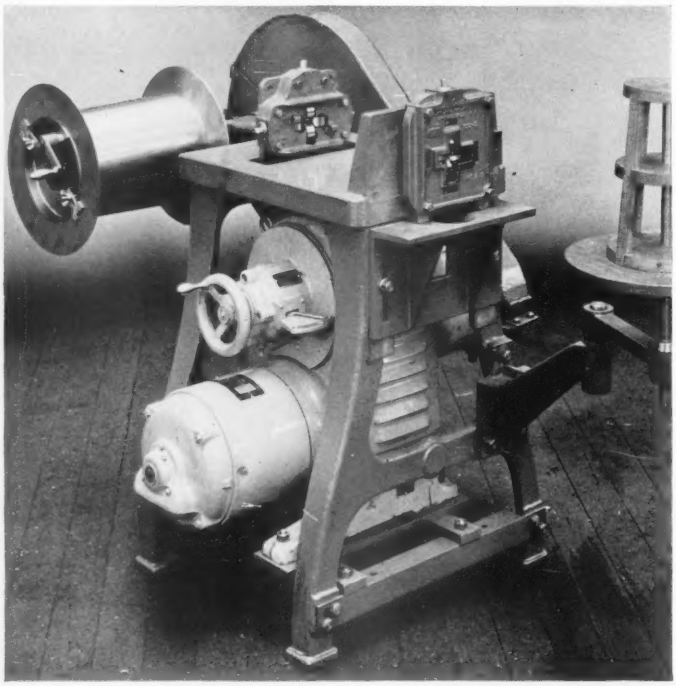
For Forming Special Shaped Wire!
For Embossing Wire!
Use A "TURKS HEAD"

It combines the functions of a wire drawing machine for pulling and for bundling the wire, but instead of the conventional type dies through which the wire is usually drawn, utilizes a system of rolls.

"TURKS Heads" are of two types — The Universal Type and The Plain Type.

THE Universal Type is used to convert round wire to rectangular sections.

THIS type has flat faced rolls only.



THE Plain Type is used for forming special shapes of wire and also for embossing designs on Wire.

THIS type may have rolls formed for special shapes or rolls with designs engraved on them.

The machine illustrated shows two "Turks Heads" mounted in tandem - - In operation the wire is taken from the pay-off reel, converted to a rectangular shape in the universal head and then embossed with a design or shaped further in the plain type head. Following that the wire is coiled on the drum shown at the left.

We Would Be Glad To Discuss Any Special Requirements With You.

STANDARD MACHINERY CO., Providence, R. I.

Is your product a "PROBLEM CHILD"?

Does your product "act up" in service? Does its manufacture run along smoothly, or must methods be changed constantly in order to attain or maintain quality? If so, some of the following questions and answers may prove helpful.

Does the base metal you are using contrast disagreeably when the plating finally wears away? (Consult A)

Do you have "grain trouble" with the surfaces of certain parts? (Consult A-B)

In etching ornamental areas, is it hard to get a clean job? (Consult A)

Would you like to sidestep preplating of some of the chrome items? (Consult A)

Is it hard to secure spinning stock that won't crack up on the chuck? (Consult A)

Do you have trouble getting ductile stock for stamping and drawing? (Consult A-B)

Do springs, slides or cams corrode in service, causing returns and refunds? (Consult A-B)

Do springs in your product weaken prematurely? (Consult A-B)

Do certain members stick or bind because of temperature changes? (Consult B)

Is there a fire hazard in your product due to sparks from colliding members? (Consult B)

Is it difficult to get anodes of uniform quality? (Consult C)

Do your anodes "pit" badly, sometimes separating completely? (Consult C)

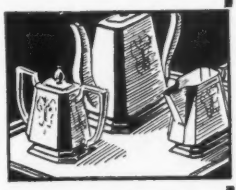
Does your nickel plating lack necessary ductility? (Consult C)

Do you have trouble with turned parts? (Consult A-B)

A

SEYMOUR NICKEL SILVER

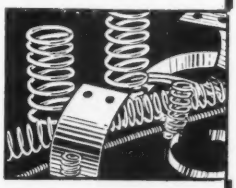
An excellent base for silver plating; its silvery white color, when exposed by wear, matches the remaining plate. Can be chromium plated without preplating. The fine ductility possible affords spinning, drawing and stamping qualities so good as often to obviate anneals. Its even grain is ideal for ornamental etching. It resists extremely corrosive conditions. It can be drawn to a high, lasting spring temper. When leaded, it is very free turning and easy on tools. In sheet, wire and rod.



B

SEYMOUR PHOSPHOR BRONZE

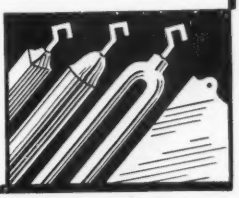
An alloy that stubbornly resists abrasion. In spring form, it undergoes the most grilling, long-time "fatigue" stresses. In ductile mixtures, it is quite satisfactory for spinning, stamping and drawing. Highly resistant to corrosion from moisture, salt air and certain mild acid solutions. Has a low co-efficient of temperature expansion and contraction. Emits no spark when struck, develops practically no "arc" when charged. May also be leaded for free turning. In sheet, wire and rod.



C

SEYMOUR NICKEL ANODES

Due to the use of virgin nickel, strict pyrometric control of the melt, and careful laboratory testing, Seymour Nickel Anodes have clean, uniform grain. This absence of impurities eliminates "pitting," and corrosion is even throughout. They yield a ductile plate that will take high polish. In all common types and shapes.



THE SEYMOUR MANUFACTURING CO., 62 FRANKLIN ST., SEYMOUR, CONN.

SEYMOUR

NICKEL SILVER - PHOSPHOR BRONZE - NICKEL ANODES

THESE Pittsburgh TAGS
Mean Something . . .
PITTSBURGH STEEL CO.
JOHN DOE CO.
ORDER 6545
HEAT 8733
GA 15/32
REJECTED
Mixed Steel
WHY REJECTED:
Off Gauge
Seams
Slivers
Fin
Laps
Scratch
Finish
Black
Rough
Pearl
Rockwell
Rockwey
Wild
Sends
Crimp
Knot Test
Torsion
Tensile
Short
Analysis
Inspector
P & P
HT. 2238
SPECIAL
SAE 1025
GA. 465
TURN No.
POT No.
CHARGED IN PREHEAT
" " ANNEALER
" " COOLER
DUMPED
TIME
DATE
Pittsburgh
14
P
PITTSBURGH STEEL CO
Pittsburgh
STAINLESS STEEL WIRE
TYPE NO. SIZE
Pittsburgh Steel Co
Pittsburgh
Spring Wire
PITTSBURGH STEEL COMPANY
12 Lbs.
Pittsburgh
Stone Wire
GALVANIZED
PITTSBURGH STEEL CO.
HOT ZINC 1½ IN COATED
No. 10
BARB FELT ROOF
WIRE NAILS
100 LBS.
"SILVER BAND"
Pittsburgh Fence
Hinge Joint Type
Style Number
Bars 1047 Inches High
Pittsburgh Fence
Welded Lawn Type
Style 736X
Pittsburgh
HINGE-JOINT
Bearing Steel
Pittsburgh

ne of the tags that make up
ontinuous, detailed record
PITTSBURGH STEEL
rom furnace to consumer.

WIRE

A COMPLETE LINE FOR ALL FABRICATING NEEDS

A PITTSBURGH STEEL product, like a banded bird, has a marked identity . . . from start to finish!

Integrated production, through a single channel, under one control, gives meaning to the label on the PITTSBURGH STEEL Wire that you buy, for whatever purpose.

PITTSBURGH STEEL begins to take definite character the moment that the raw materials are charged into a furnace. Every heat is marked with a number that follows it through all the successive operations of the mill. The analysis and intended properties of the steel are known. It is treated, modified, and adapted at every stage, with its destined specific use in view.

The PITTSBURGH STEEL product that you find so much to your liking will prove satisfactory to your shop men and yield all the anticipated economies, every time, because of the remarkable uniformity secured. Duplicate your specifications and the production of your order will be duplicated. This is your assurance when you buy PITTSBURGH STEEL WIRE.

PITTSBURGH STEEL COMPANY, PITTSBURGH, PA.

NEW YORK CLEVELAND DETROIT CHICAGO MEMPHIS TULSA HOUSTON LOS ANGELES

An Organization of Wire Specialists—established 37 years

The Ironsides Company

COLUMBUS, OHIO, U.S.A.

SPECIAL LUBRICANTS AND PRESERVATIVES

SHIELD PRODUCTS

GENERAL LUBRICANTS
- GEAR SHIELD, BELT SHIELD
- HOT AND COLD NECK SHIELD
- WIRE ROPE FILLER AND SHIELD
- FIBRE ROPE FILLER AND SHIELD
- CAM-PLUNGER SHIELD
- UNIVERSAL BEARING SHIELD
- WIRE DRAWING SHIELD
- CORE OILS
- COLD STRIP SHIELD

AUTOMOTIVE LUBRICANTS
- EXTREME PRESSURE LUBRICANTS
- CHASSIS LUBRICANTS
- AUTO-GEAR SHIELD
- TRACTOR-GEAR SHIELD

MISCELLANEOUS PRODUCTS
- ROOF AND STACK PAINTS
- IMPROVED TORMAY OILERS

PHONE ADAMS 2228

CABLE ADDRESS
IRONSIDES. COLUMBUS
USE WESTERN UNION CODE

P O BOX - 1999
COLUMBUS, OHIO U S A

TO WHOM IT MAY CONCERN

For 45 Years

Ironsides Shield Products Have Lubricated

Metal Working Mills, and

NOW

S-300

A New Development in DRY STEEL DRAWING LUBRICANTS

JOINS

The Already Successful Family of Ironsides Wet Drawing Lubes.

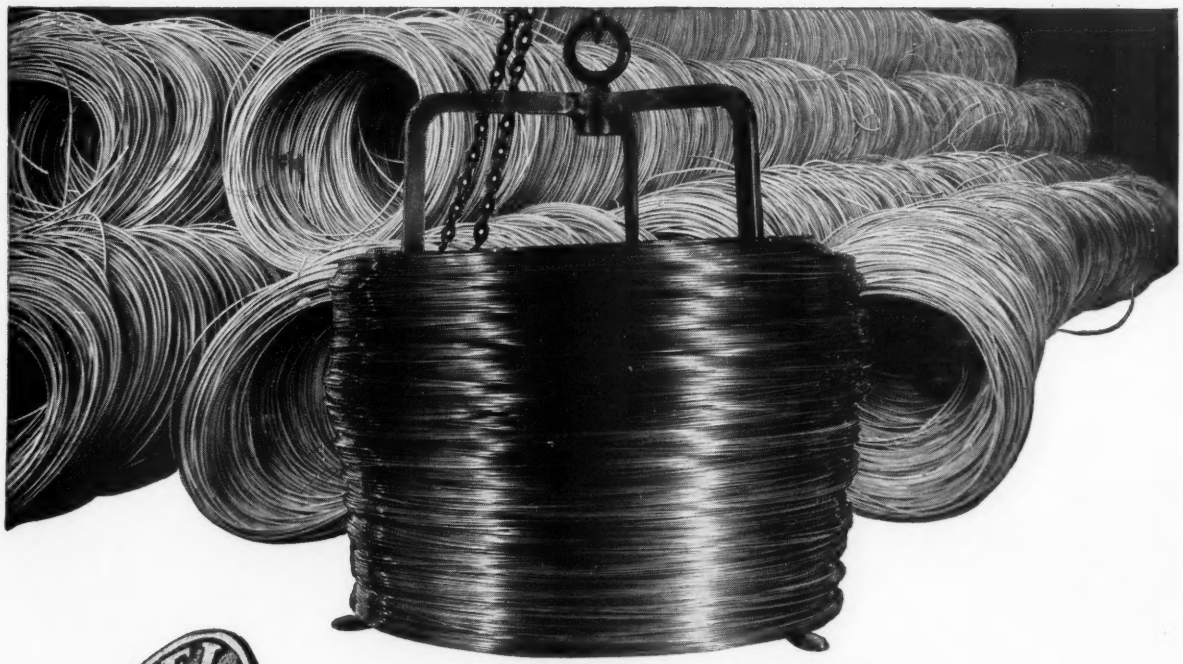
ADVANTAGES:

Bright Finished Wire
Water Repellent Coating For Rods
True and Sharp Cold Heading
Cost Economy

Particulars and Demonstration Upon Request

THE IRONSIDES COMPANY

COLUMBUS, OHIO.

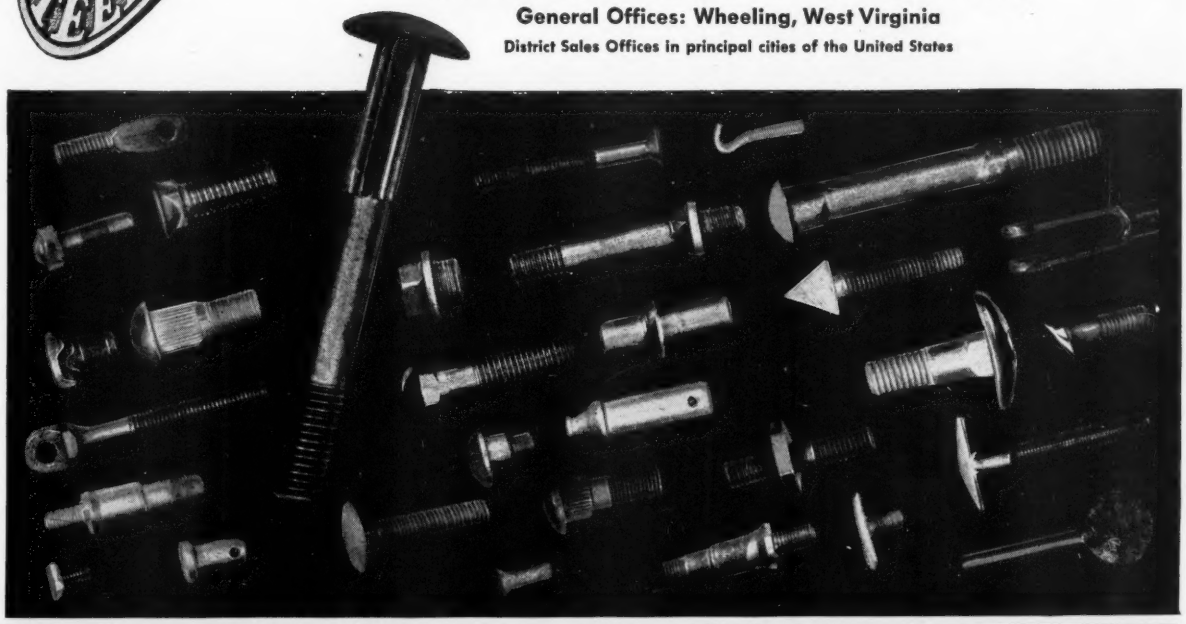


WHEELING puts emphasis on quality through every step of rod and wire manufacture . . . and quality is assured the fabricator. Wheeling facilities, and Wheeling control of these facilities, are thorough and complete.

WHEELING STEEL CORPORATION

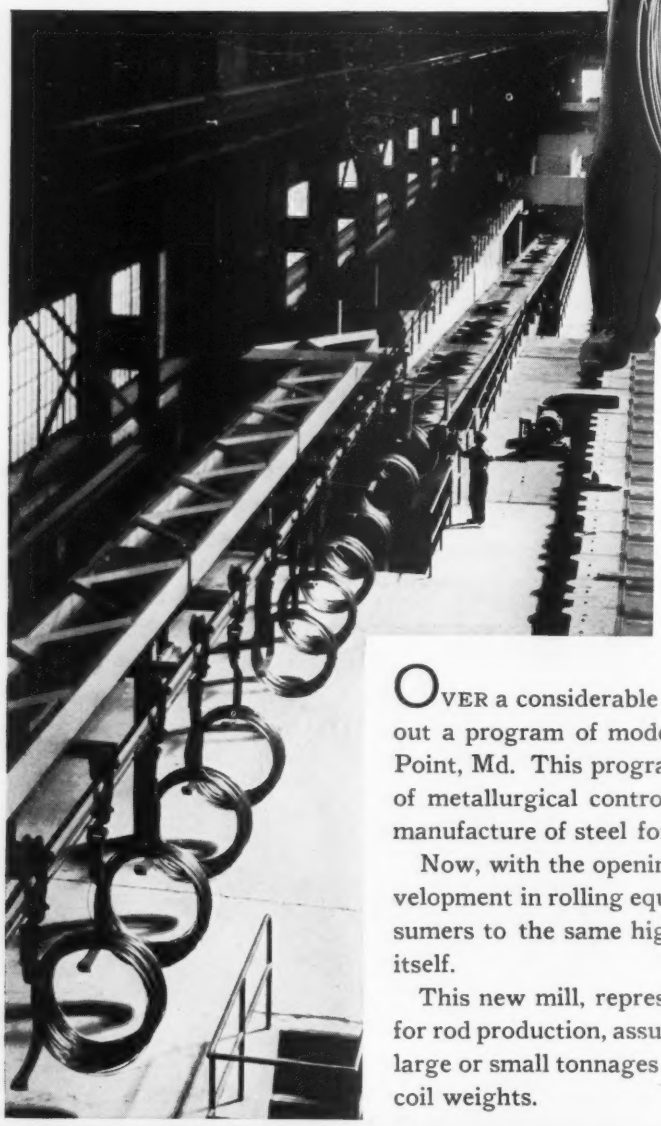
General Offices: Wheeling, West Virginia

District Sales Offices in principal cities of the United States



IT'S WHEELING STEEL

Complete service



for users of

Wire Rods

OVER a considerable period of time Bethlehem has been carrying out a program of modernization at the Maryland Plant, Sparrows Point, Md. This program, together with a highly developed system of metallurgical control, brings a high degree of precision to the manufacture of steel for quality products.

Now, with the opening of a new additional rod mill, the latest development in rolling equipment is provided to finish steel for rod consumers to the same high standards maintained in the steel making itself.

This new mill, representing the latest development in equipment for rod production, assures highly efficient service on either large or small tonnages in a wide range of grades, sizes and coil weights.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

FARREL ROLLING MILL MACHINERY

ROLLING MILLS—For ferrous and non-ferrous metals. Complete rod mills from furnace to coilers.

ROLLS—Cupola and electric furnace chilled and alloy iron, heat treated Farrel Ni-Hard and steel.

ROD MILL TABLES AND MANIPULATING EQUIPMENT

UNIVERSAL MILL SPINDLES

ROD COILERS

LEAD PRESSES for PIPE or ROD

ROLL GRINDING MACHINES

ROLL CALIPERS

CINDER CRUSHERS

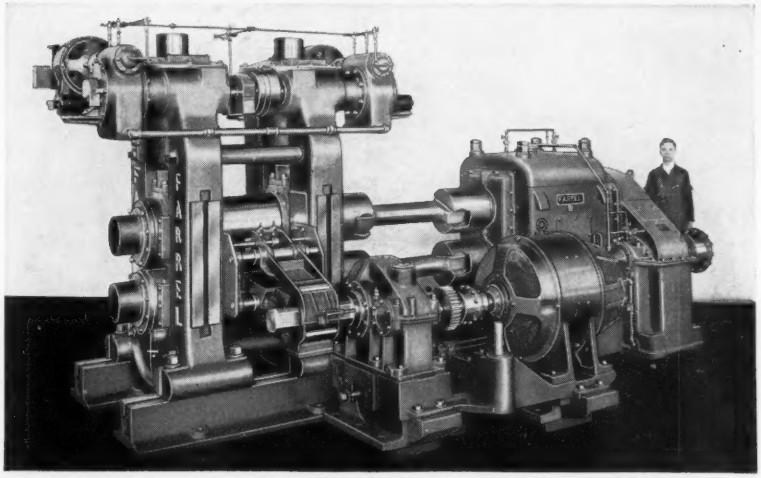
GEARS

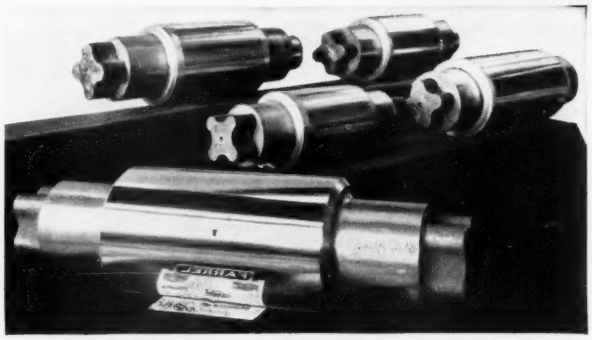
MILL PINIONS

PINION STANDS

GEAR DRIVES

FLEXIBLE COUPLINGS



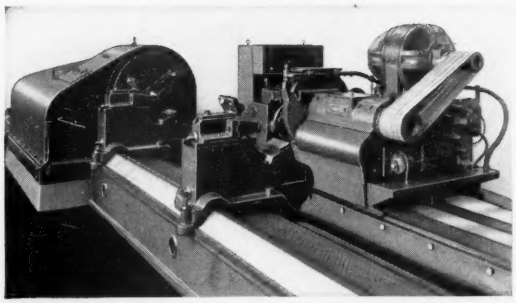


FARREL ROLLING MILLS

Built in any size for any specific requirement. Advanced features of design and construction permit high speed operation, increase output, improve quality and reduce production costs.

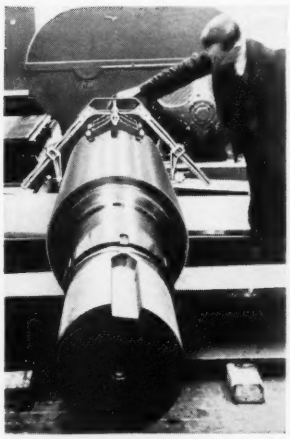
FARREL NI-HARD ROLLS

Superior in quality, precision and durability. Combine hardness of 85 to 90 scleroscope with high strength and flawless surface. Ideal for h'gh finish sheets, they produce a higher quality finish, have longer life and cut ton-cost of output.



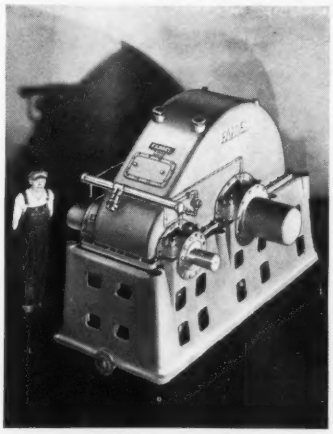
HEAVY DUTY ROLL GRINDERS

Designed for better, faster and cheaper grinding. Equally capable of heavy roughing or fine finishing on rolls of any material. Grind perfect surface free from marks of any kind, with straight, concave or convex contours of exact symmetry and accuracy. Built in six standard sizes to grind rolls up to maximum diameters of 24″, 28″, 36″, 44″, 50″ and 60″, and any lengths required.



ROLL CALIPERS

Provide exact check of roll accuracy. Five sizes to measure rolls from 4″ to 50″ diameter.



GEAR DRIVES

Single, double and multiple reduction units, any ratio, any speed, any power.

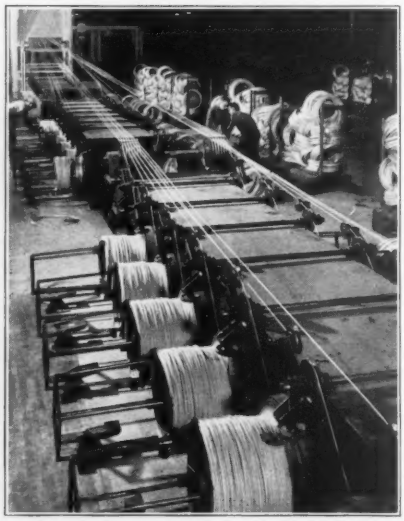
FARREL-BIRMINGHAM COMPANY, Inc.

ANSONIA, CONN.

New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

Now— FULL FLEXIBILITY! in ELECTRO · GALVANIZING WIRE

• Meaker Process for Electro-Galvanizing Round Wire has added full variable control of strand speed and . . . full control of coating weights on strands or groups of strands. Meaker Process solves the problem of electro-galvanizing various wire gauges simultaneously in the same unit.



As a result, to those manufacturers who must galvanize a variety of wire gauges Meaker Process now offers fully flexible electro-zinc equipment engineered to meet their exact requirements.

Meaker Process Also Provides . . .

- Full range of coating thicknesses — the heaviest obtainable by any process, or the lightest.
- Uniform distribution at any weight.
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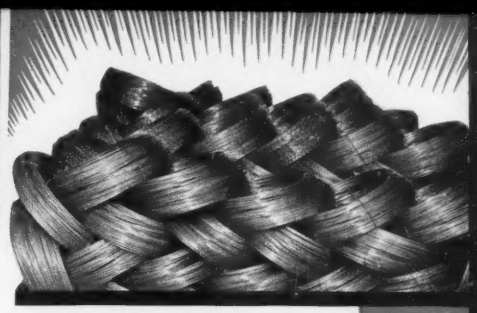

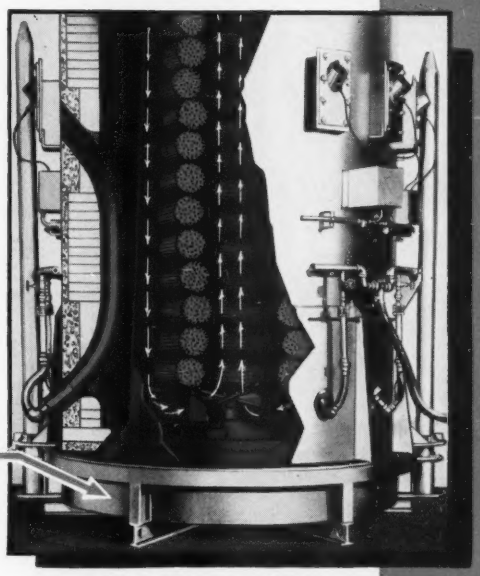

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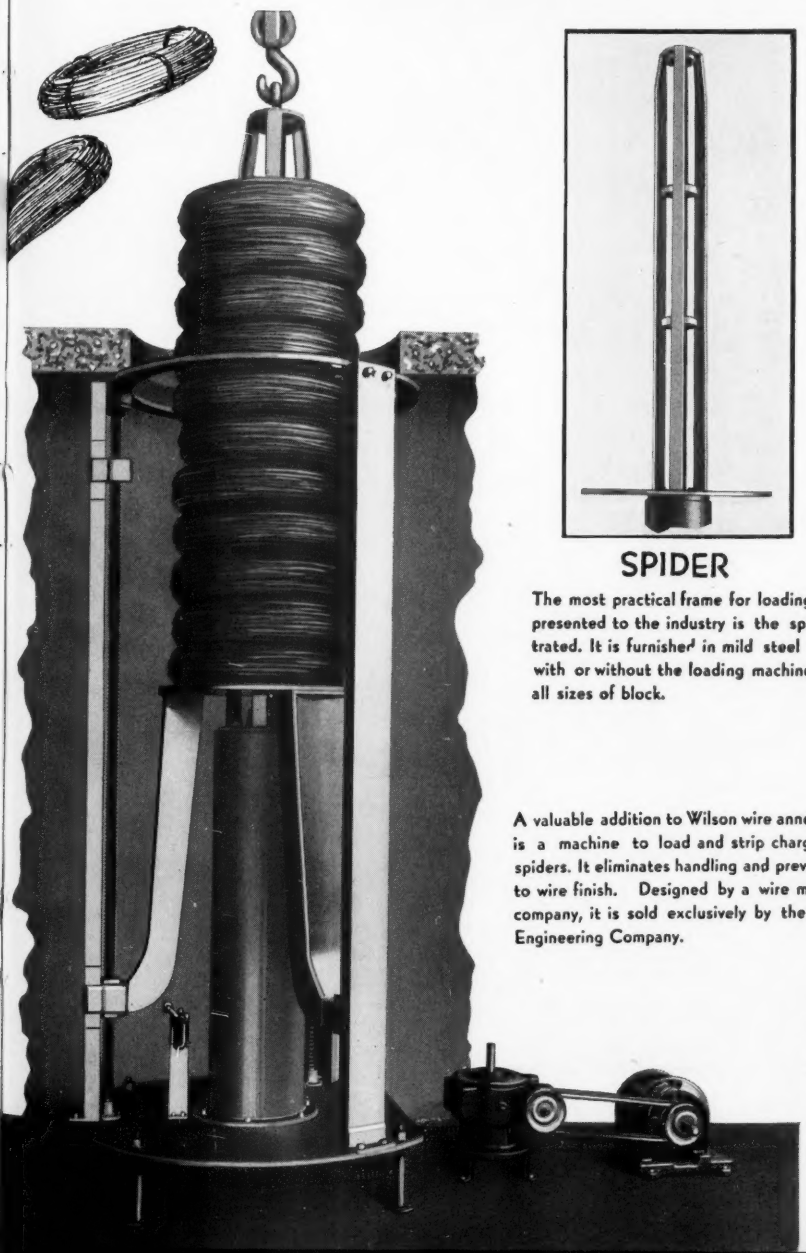

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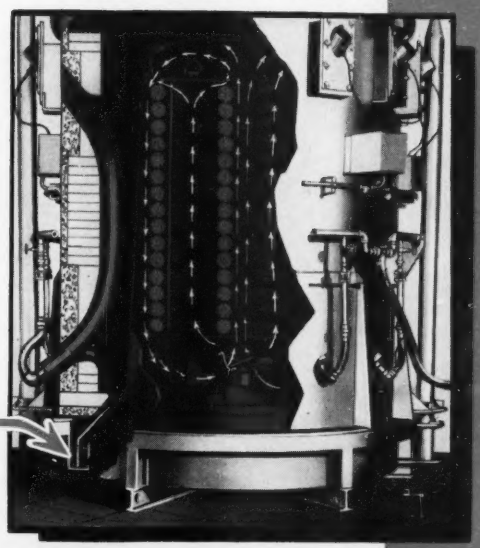

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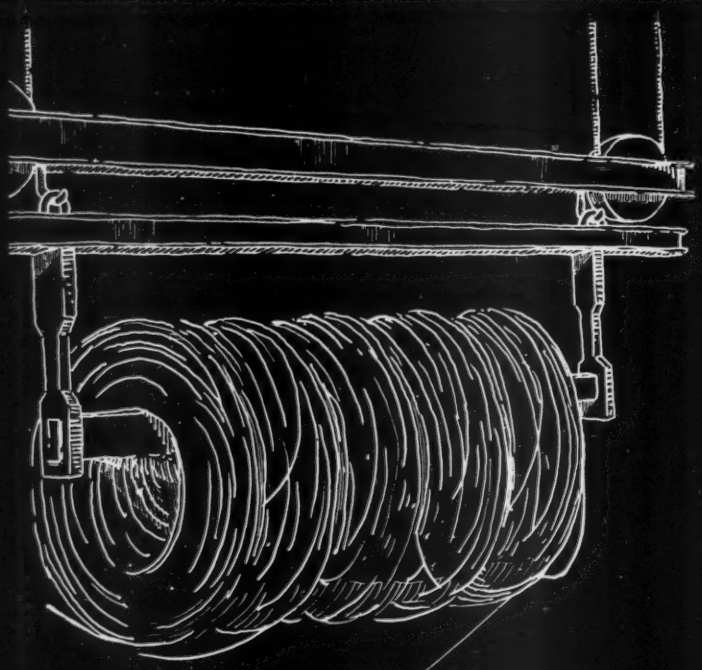

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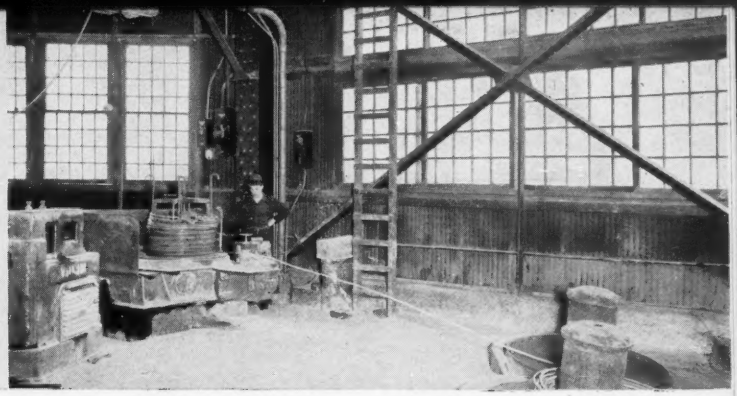

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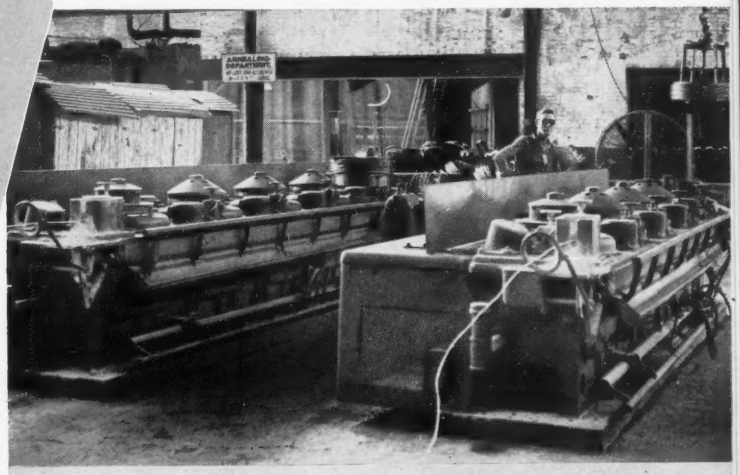

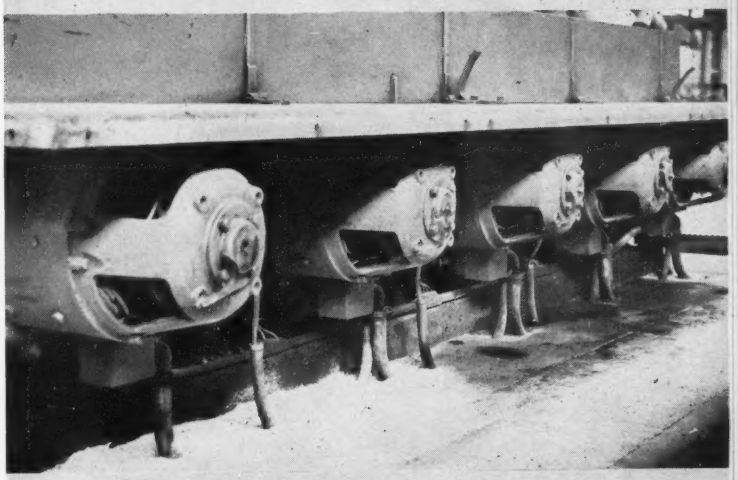

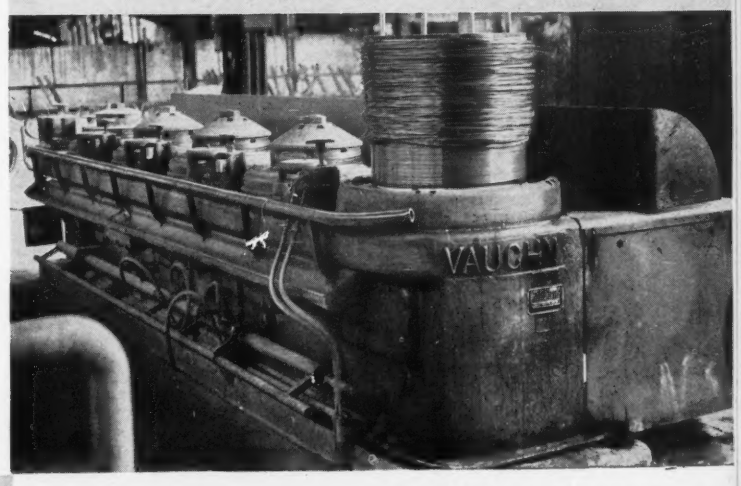

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A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol 13 OCTOBER, 1938 No. 10

Designated as

Official Publication By The Wire Association

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Publication Office: Washington, N. J.
Executive Office: 17 E. 42nd St., New York, N. Y.

Annual Subscription, U. S. $5.00, Canada $5.00

Convention Issue, Price $1.00

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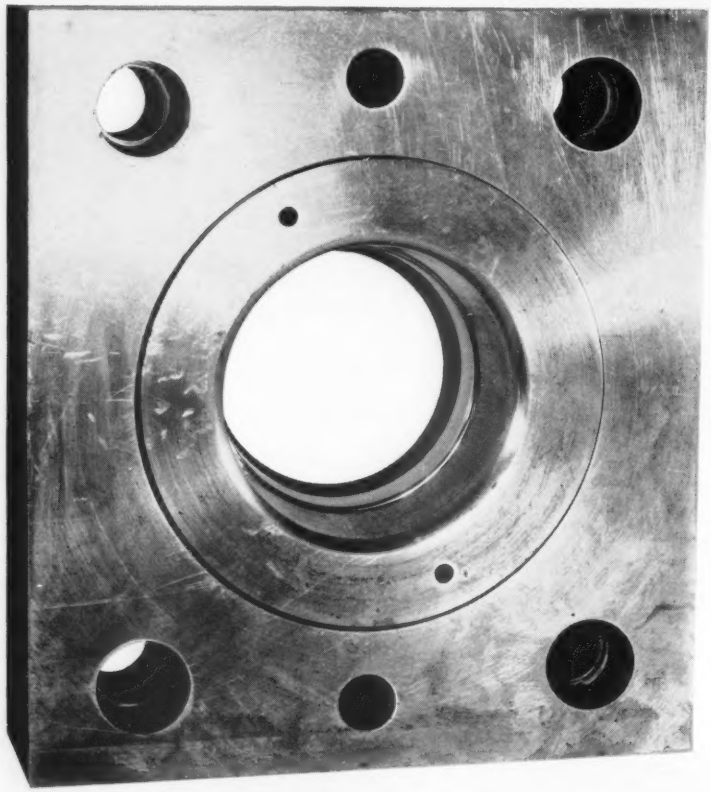

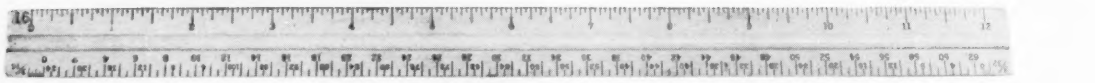

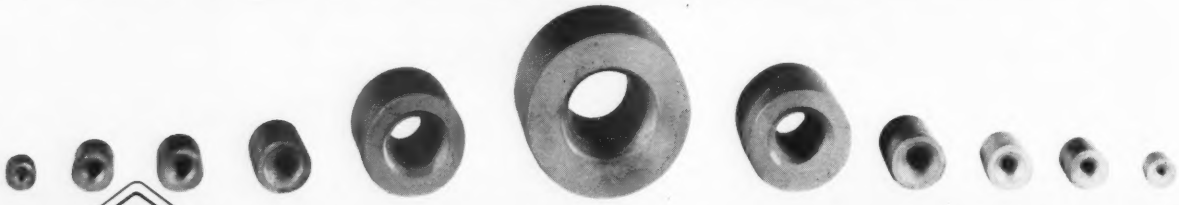

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DRAWING --- ROLLING--- EXTRUDING --- FORMING --- FABRICATING

Vol. 13 OCTOBER, 1938 No. 10

Rope Wire

By Walter R. Bloxdorf,
Metallurgist, Macwhyte Company,
Kenosha, Wisconsin

Each phase of manufacture of this class of wire or each single property is sufficiently comprehensive to warrant separate discussion. Realizing this, together with the fact that so little published information exists on rope wire at present, the author has written this paper so as to cover the subject in a broad manner. By so doing, it is hoped that sufficient interest will have been stimulated so that at some future time other papers covering in detail either one of the phases of manufacture or the properties of rope wire will be presented.

Introduction

WIRE rope has served as an important tool in the development of our present state of civilization. It has been in use for approximately one hundred years. During this period of time, its advantages and efficiency became more and more apparent until today it is called upon to perform tasks in a wide field of enterprise.

✦ ✦ ✦

NOT the least important of the component parts of a wire rope is cold drawn wire. The satisfactory and economical performance of wire rope depends in a large measure upon the quality of the wire. The first wire ropes used were fabricated with an Iron grade of wire having relatively low tensile strength. However, upon the gradual widening of the field of usage of wire rope, the demand for higher grade and better quality steadily rose until today it is necessary to manufacture a number of grades of wire each possessing properties and characteristics particularly adapted to the conditions under which the wire rope is to be used.

✦ ✦ ✦

THERE are today a few applications of wire rope of such a nature as to demand the use either of wire drawn from non-ferrous metals, such as copper, phosphor bronze, and monel metal, or of stainless steel particularly the Austenitic variety. With the exception of stainless steel, the comparatively low tensile strength of wire produced from these metals limits their adaptation to wire rope. There are, also, some applications which dictate the use of zinc-coated wire which is available in a rather wide range of tensile strength. Moreover, in most of the cases where the use of wire rope is indicated, such rope is fabricated from bright, cold drawn carbon steel wire of one or another grade. This paper is concerned primarily with a discussion of the production and properties of this important class of wire.

WALTER R. BLOXDORF

Born in Kenosha, Wisconsin in 1905. Employed in the chemical laboratory of the Macwhyte Company from 1923 to 1924. Studied chemical engineering at the University of Wisconsin from 1924 to 1928. Upon completion of these studies, re-entered the employ of the Macwhyte Company in the chemical and metallurgical department. Served as Metallurgist since 1931. Member of The American Society for Metals, The Electrochemical Society, The American Society for Testing Materials, and The Wire Association.

✦ ✦ ✦

AS previously stated, carbon steel rope wire is available in a number of grades. These grades are commonly referred to as Iron, Traction Steel, Cast Steel, Mild Plow or Extra Strong Cast Steel, Plow Steel, and Improved Plow Steel. The chief difference between each grade lies in tensile strength which increases successively from Iron to Improved Plow

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Steel. The actual minimum tensile strengths for each grade have been quite definitely established in the **Federal Specification for Wire Rope, RR-R-571.** These minimum tensile values are shown in Table I.

TABLE I.

Minimum Tensile Strength Values for Rope Wire Set Forth in Federal Specification for Wire Rope, RR-R-571

Grade	Required Minimum Tensile Strength, lbs. per sq. in.
Iron	70,000
Traction Steel	160,000
Cast Steel	170,000
Extra Strong Cast Steel	190,000
Plow Steel	210,000
Improved Plow Steel	230,000

✦ ✦ ✦

A HIGH quality rope wire must possess other properties besides tensile strength. Among these may be mentioned ductility, toughness, resistance to deformation, and resistance to failure through fatigue. The production of cold drawn steel wire having all of these properties and characteristics in a high and well balanced degree is dependent chiefly upon the following factors, namely,

1. **Selection of composition and type of raw material consisting of steel wire rod.**
2. **Proper heat treatment.**
3. **Manipulation of heat treated material which consists of cleaning, coating, baking, and subsequent cold drawing.**

✦ ✦ ✦

Selection of Material

MOST of the rope wire in use today is made from fully-killed steel produced by the open-hearth process, either acid or basic. However, some low carbon, rimmed steel is used in producing a small quantity of wire of Iron grade. The carbon content of the steel primarily determines its suitability for use in the making of rope wire of a given grade. This is the case because carbon content influences greatly the tensile strength of the wire. Other elements, such as manganese, sulphur, phosphorus, and silicon are of considerable importance and must be held within proper and predetermined limits. Suitable rope wire of a certain grade can be made from steels having chemical analyses of a surprisingly wide range. However, the various grades are usually made from steels having the average chemical compositions shown in Table II.

✦ ✦ ✦

ALL wire from the smallest to that having a diameter of about 0.080″ (14 gauge) can, and usually is, made from a #5 gauge hot-rolled wire rod. A limited number of sizes larger than 0.080″ diameter can be made from a #5 gauge rod, but, to do so does not represent the best practice. For making the larger sizes, a heavier wire rod must be employed. The sizes of rod most commonly in use are #4 gauge (0.225″), #1 gauge (9/32″), $\frac{5}{16}$″, $\frac{3}{8}$″, $\frac{7}{16}$″, and $\frac{1}{2}$″.

✦ ✦ ✦

CAREFUL supervision of all operations attending the hot-rolling of wire rod is very necessary if the rod is to possess a quality rendering it suitable for rope wire. The heating to which the steel is subjected at the various stages must be controlled so that temperatures encountered are uniform and not too high and that scaling is not excessive. In the final rolling from the billet, the use of water on the rolls must be carefully regulated in order to insure against "hard spots" in the rod. The finishing temperature is of importance, for the "as rolled" grain size and structure of the rod are quite dependent upon it.

✦ ✦ ✦

THE finished rod must be as round as it is possible to make it. It must have a surface free from fins, laps, seams, slivers, rolled in scale or oxide, and any defect which impairs its smoothness of finish. The amount of surface scale should be light. Assuming that proper discard of 'pipey' and segregated metal has been made during the various stages of hot-rolling, it is always good practice to test both ends of each coil of wire rod before pronouncing it satisfactory for use in rope wire manufacture. A very simple test can be employed to detect the presence of internal defects such as 'pipe' or segregation. This test consists of bending a sample of the rod back and forth through approximately 90 degrees until fracture occurs. If internal defects are present, they will be revealed upon examination of the resultant fracture. If surface imperfections, such as laps or seams, are present, they will, also be seen in the frac-

TABLE II.

Average Chemical Composition of Steels Used in the Production of Rope Wire

Grade of Wire	Carbon, %	Manganese, %	Sulfur and Phosphorus, %	Silicon, %
Iron	0.05-0.25	0.30-0.60	0.040 max.	0.20 max.
Traction Steel	0.25-0.45	0.50-0.70	0.040 max.	0.20 max.
Cast Steel	0.40-0.50	0.50-0.80	0.040 max.	0.15-0.25
Extra Strong Cast Steel	0.50-0.60	0.50-0.80	0.040 max.	0.15-0.25
Plow Steel	0.60-0.75	0.50-0.80	0.040 max.	0.15-0.25
Improved Plow Steel	0.65-0.85	0.50-0.80	0.040 max.	0.15-0.25

ture. Making a small notch or nick in the surface of the rod sample prior to bending in order to expedite fracture is not advisable, for the fracture thus obtained presents a different appearance which masks the presence of small internal defects. The use of a hot hydrochloric acid etch will, also, serve as a rapid means for revealing the presence of internal and surface defects.

✦ ✦ ✦

IN addition to the selection of steel of the proper chemical composition for a given grade of wire and subsequently rolling it into a wire rod having the physical characteristics pointed out, consideration should also be given to the type of steel. By this is meant its grain size and normality as determined by the **McQuaid-Ehn** grain size test. Everyone is more or less familiar with the wealth of data and information which has thus far been compiled on this test and the importance of its significance. The technical aspects as regards wire manufacture have been quite fully discussed in **Mr. B. L. McCarthy's** paper entitled, **"Grain Size And Its Influence On The Manufacture Of Steel Wire,"** presented at the 1935 Annual Meeting of the Wire Association held in Chicago, Illinois. In this present paper, **McQuaid-Ehn** grain size and normality will be treated briefly.

✦ ✦ ✦

FOR rope wire, a preference for normal steels having a coarse to medium grain size is usually indicated. The reason for this lies in the fact that these steels, due to their lower reaction rate, will develop, upon being subjected to the quench attending the Patenting treatment, a grain structure consisting of more finely laminated Pearlite and a minimum quantity of free Ferrite. This type of structure is the most desirable for it has a great capacity for receiving cold work. Generally, the use of steels exhibiting a high degree of abnormality, a duplex or 'mixed' grain size, or a very fine grain upon being subjected to the **McQuaid-Ehn** grain size test is avoided. However, it is the opinion and experience of the author that fine grain normal steels can be made to respond to the Patenting treatment in a manner equal to that of coarse grain normal steels. To accomplish this requires changes in and careful control of the Patenting treatment. The resultant patented steel can be drawn into very satisfactory rope wire.

✦ ✦ ✦

Heat Treatment

THE ability to cold draw rope wire steel the extent necessary to obtain the required physical characteristics in the finished wire depends in large measure upon the uniformity and type of its grain structure. In spite of all the precautions taken in the rolling of the wire rod, there are very few, if any, wire rods which will exhibit the same type of grain structure from one end to the other. This is primarily due to the fact that, upon the cooling of the coil of wire rod after the hot-rolling operation, individual sections are subjected to different rates of cooling through the critical range depending upon their position in the coil. The result is that the rod possesses grains of Pearlite of different degrees of fineness and a variable state of Ferrite precipitation. The photomicrographs shown in Figures 1, 2, 3, and 4 illustrate the non-uniformity of grain structure frequently found to exist in a single coil of hot-rolled wire rod having a nominal carbon content of 0.65%.

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THESE structural differences indicate both a non-uniformity of physical properties in the rod itself and a difference in the reaction

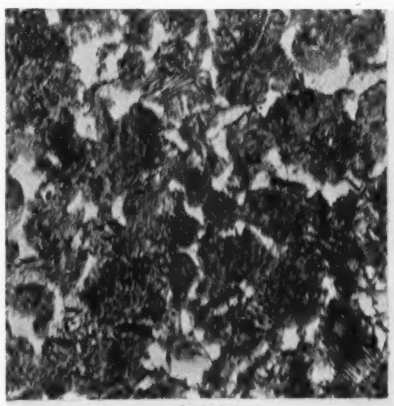


Figure 1.

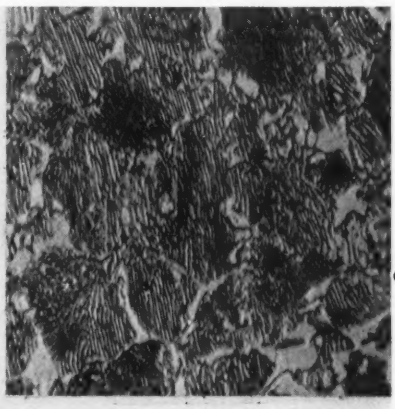


Figure 2.

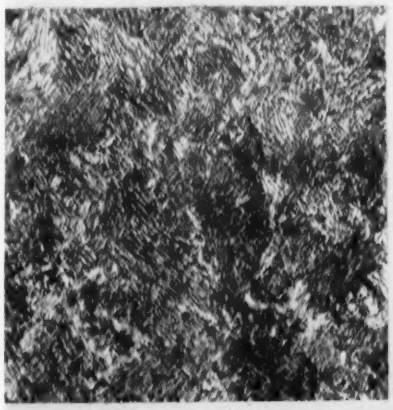


Figure 3.

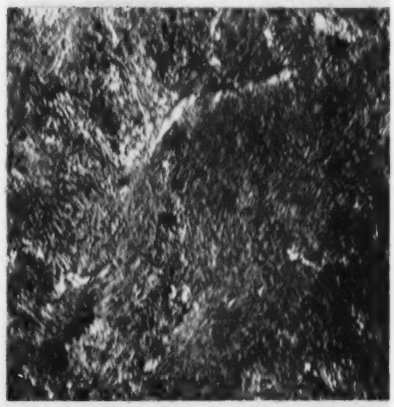
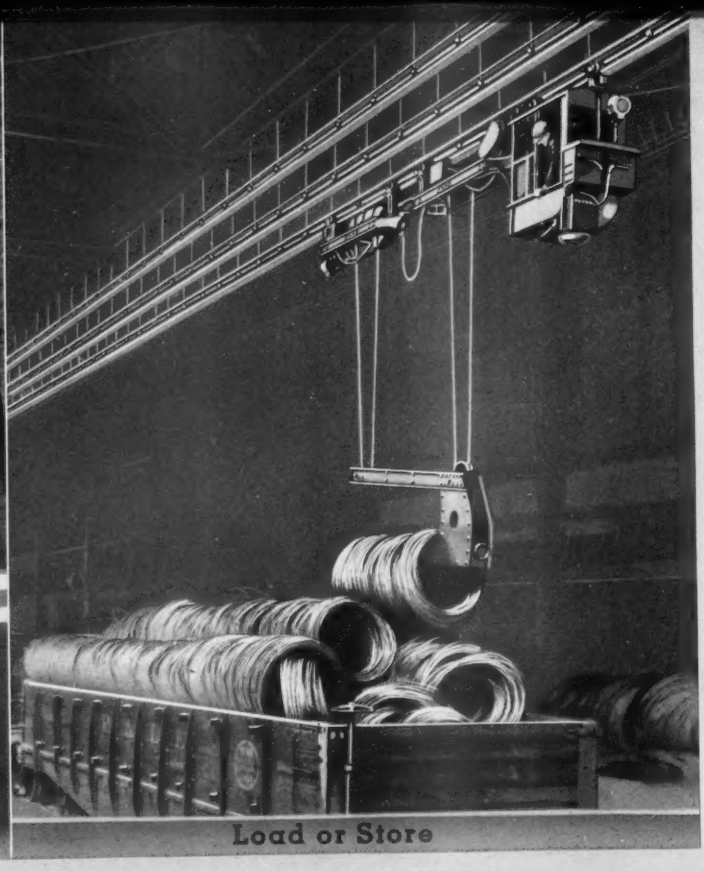


Figure 4.

Showing Different Grain Structures Existing in the Same Coil of 0.65% Carbon, #5 Gauge, Hot-Rolled Wire Rod.

Magnification of All Photomicrographs—750X.

Pick Up



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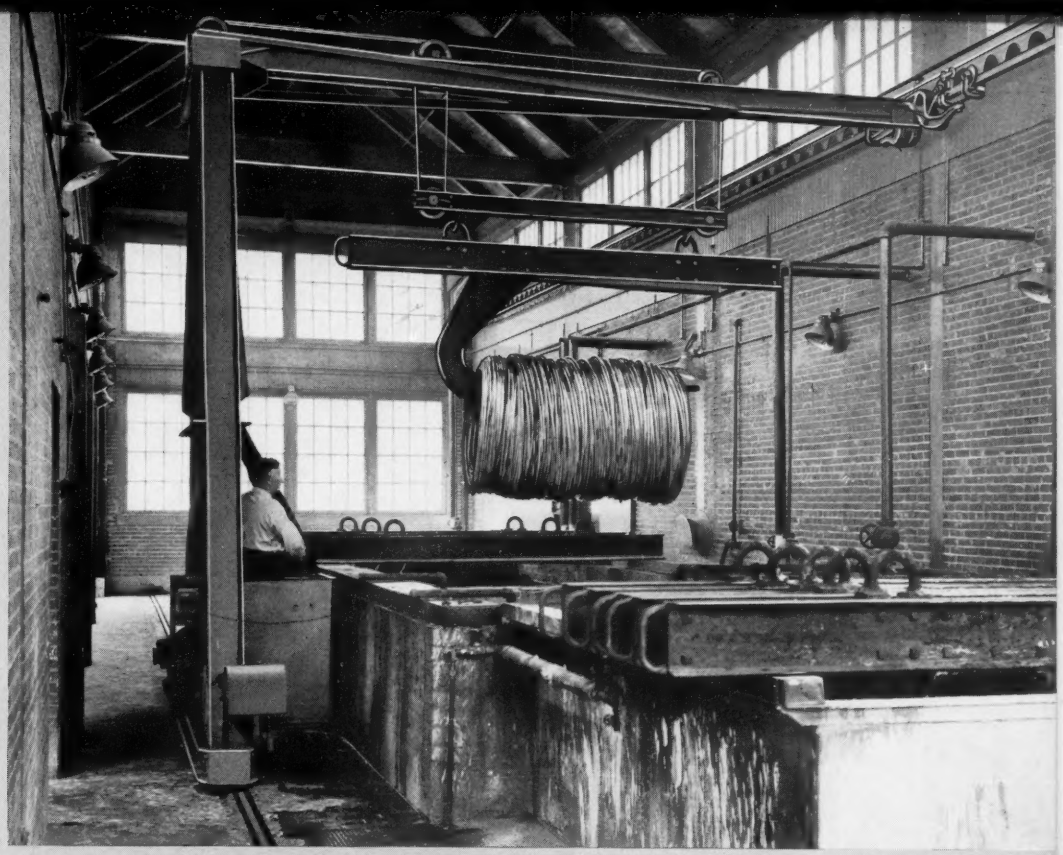

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of various sections of the rod to cold drawing. Indeed, if the Pearlite be too coarsely laminated in certain portions, attempts to cold draw the rod any appreciable extent will not be successful for non-uniform flow of the metal will occur and brittleness with possible breakage will result. By subjecting the rod to a Patenting treatment, all of these structural differences existing in the hot-rolled condition can be definitely eliminated. Such treatment will induce a proper and uniform structure throughout the rod thereby conditioning it for subsequent cold work.

✦ ✦ ✦

THIS preliminary Patenting of wire rods to be used for rope wire is a very sound practice. For the sake of uniformity and quality in the finished wire, it should be applied to all wire rods whose carbon content is above about 0.55%. Although this latter statement is one of more or less controversial character, nevertheless the author feels that, unless such Patenting is resorted to, trouble will frequently develop in the wire mill which may result in unjustifiable blame for poor quality material being placed upon either the steel or the rod maker. Of course, the need for such treatment is more apparent when dealing with wire rods in the higher carbon content ranges. In the case of rods having a carbon content of from about 0.25% to 0.50%, preliminary Patenting is not entirely necessary provided the total amount of cold drawing which the hot-rolled rod is to receive is not excessive. However, Patenting of these lower carbon rods certainly does no harm, and is to be encouraged even though not strictly economical.

✦ ✦ ✦

WIRE rods whose carbon content is less than 0.25% need not be, and seldom are, subjected to any preliminary heat treatment. Their relatively high ductility, their soft nature, and the ease with which they lend themselves to plastic deformation in the wire drawing die enable them to be considerably cold drawn in their hot-rolled structural condition before the need for any heat treatment arises.

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PATENTING, to which reference has just been made, is the name of the heat treatment to which wire rod or wire of a given diameter is subjected prior to being drawn to wire of a smaller diameter having certain established physical characteristics. It consists essentially of heating the rod or wire to some one temperature considerably above its critical range, holding it at this temperature for a given period of time, and finally cooling it at such a rate as to produce a type of grain structure considered most suitable for cold work. It is the heat treatment which is universally applied to all steels of carbon contents ranging from 0.30% to 0.85% which are to be cold drawn into rope wire. Since the percentage of reduction in cross-sectional area due to cold drawing which all sizes of rope wire receive in being finished from the last heat treatment point usually varies from about 65% to 90%—the exact percentage depending upon the properties desired in the finished wire and the established practice of the individual manufacturer—and, since rope wire must be made in a large number of sizes, it follows that a wide range of wire sizes are subjected to the Patenting treatment. The purpose of the treatment is to produce a uniform and homogeneous grain structure consisting of a relatively coarse grain, Pearlite of extremely fine lamination, and of a minimum quantity of free Ferrite consistent with the carbon content of the steel.

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THE temperatures employed in Patenting can be varied over a rather wide range. Differences of opinion as to what temperatures are best for various types of steel undoubtedly prevail. There are, however, very definite advantages to be gained by resorting to temperatures of from 1800° F. to 1850° F., which might be termed high. Among these may be mentioned:

1. **Decrease in time required for the wire to reach the desired temperature.**
2. **Assurance of complete solution and uniform dispersion of the carbon in the gamma iron while within the Austenitic field.**
3. **Promotion of a coarse Austenitic grain.**
4. **Increased rate of cooling through the transformation range upon subjecting the steel to the quench, thereby promoting the grain structure desired.**

✦ ✦ ✦

ACTUALLY, maximum temperatures employed by different manufacturers will be found to vary considerably. It is not uncommon to find temperatures anywhere from 1600° F. to 1900° F. in use today—each manufacturer finding some reason for justifying his particular temperature.

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THE period of time the wire or rod is held at the maximum temperature is, with a given length of furnace, a function of the linear speed at which it is led through the furnace. The larger the wire or rod the lower the linear speed must be in order to insure adequate heating. No hard and fast rules can be laid down relative to proper speeds for material of different diameters. Here again, it is pointed out that a rather wide variation in speeds will be found to be in use by different manufacturers.

✦ ✦ ✦

THE maximum patenting temperature and the linear speed of the wire or rod are related factors influencing the degree of grain coarsening and carbide distribution desired in the patented material. In the larger sizes particularly, more attention to linear speed control must be exercised when patenting at lower temperatures than when patenting at the higher temperatures. This is evident from a study of the photomicrographs shown in Figures 5, 6, 7, 8, and 9. The material represented in these photomicrographs is a #5 gauge wire rod of 0.46% carbon content.

✦ ✦ ✦

PATENTING of all of this material was effected in a 50 foot, gas-fired patenting furnace followed by air-quenching from the maximum patenting temperature.

✦ ✦ ✦

THE manner of quenching from the maximum patenting tem-

Showing the Effect of Patenting Temperature and Linear Speed Upon the Structure Produced in a 0.46% Carbon, #5 Gauge, Hot-Rolled Wire Rod. Magnification of All Photomicrographs—100X.

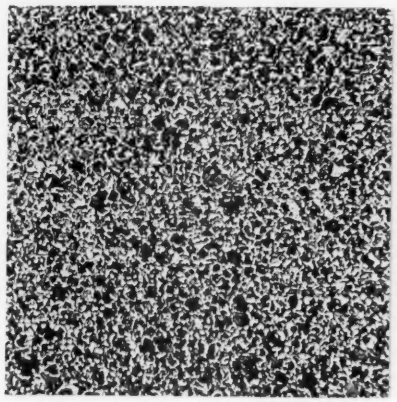

Figure 5.
Wire Rod in Hot-Rolled condition.

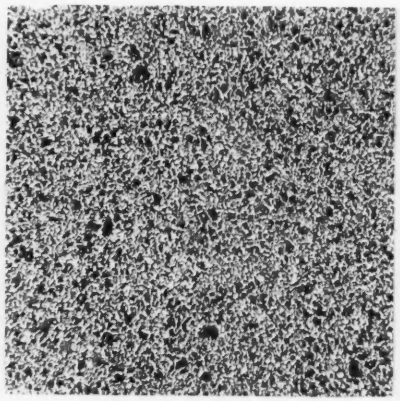

Figure 6.
Same as Fig. 5 after Patenting at 1700° F. at a linear speed of 21 feet per minute.

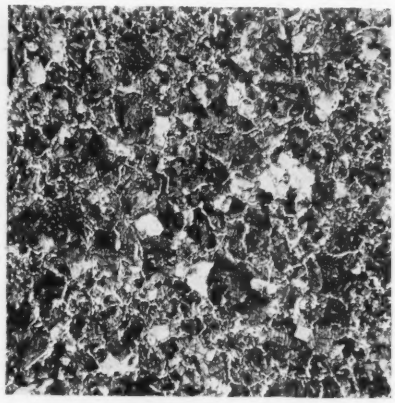

Figure 7.
Same as Fig. 5 after Patenting at 1700°F. at a linear speed of 4 feet per minute.

perature is of great importance insofar as obtaining the desired fine Pearlite in the rod or wire is concerned. The quenching media commonly employed in Patenting rope wire are air, molten lead, and molten salts. The finer sizes of stock can be satisfactorily quenched in air. Molten lead or salts are to be preferred for the larger sizes in order to insure a good grain structure and uniform physical properties. These latter media are maintained at various temperatures ranging from about 800° F. to 1000° F. depending primarily upon Patenting temperature and linear speed, size and composition of stock. Upon air quenching relatively small size stock, especial consideration and attention must be given to its composition, patenting temperature, and linear speed. If the temperature be too high and the speed too great, the grain structure produced in the patented stock will be very undesirable. The photomicrograph shown in Figure 10 illustrates such a structure consisting largely of Troostite (Dark Areas) and residual particles of Martensite (White Area). This particular material was a wire having a diameter of 0.062″ and a carbon content of 0.79%. The rope wire resulting from attempts to cold draw structures of this type would be brittle and of generally poor quality.

✦ ✦ ✦

THE physical properties imparted to rope wire or wire rod through the Patenting treatment are dependent upon the following factors, namely, composition and size of stock, linear speed, maximum Patenting temperature, and temperature of the quenching medium, if it be either lead or salt. By change and control of one or more of these factors, the tensile strength particularly of the stock, can be varied over a rather wide range. In Figure 11 is given a range in tensile strength for Patented stock of various carbon contents. This range is suggested as one of reliability and safety. After making some study of the Patenting procedure necessary to obtain a good grain structure, it became apparent that, if Patented tensile strengths fell fairly well within this range, other physical properties were good, a satisfactory grain structure was produced, and the Patented stock could be cold drawn into rope wire of high quality.

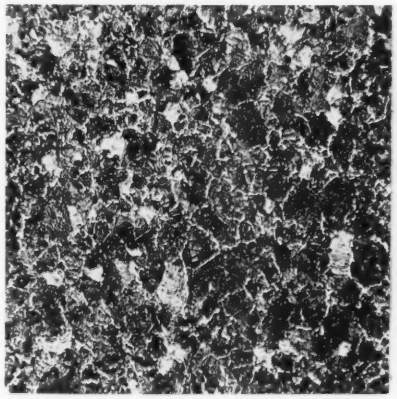

Figure 8.
Same as Fig. 5 after Patenting at 1830° F. at a linear speed of 21 feet per minute.

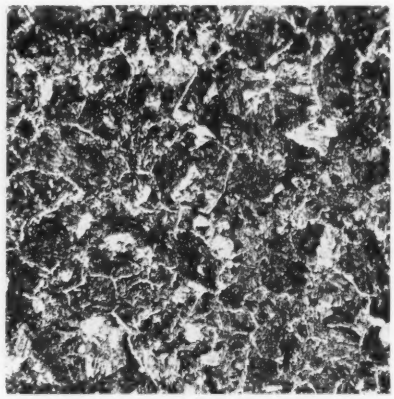

Figure 9.
Same as Fig. 5 after Patenting at 1830° F. at a linear speed of 4 feet per minute.

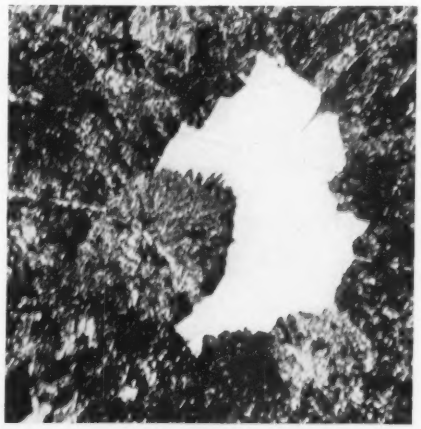

Figure 10.
Magnifications—500X.
Showing Martensite and Troostite Resulting from Too Drastic A Quench Attending the Patenting Treatment.

THE conventional method of Patenting comprises the use of either a gas-fired furnace, an oil-fired furnace, or a furnace heated electrically. A relatively novel and very interesting method, designated as **Electric Direct Resistance Patenting,** was described in an article by **Mr. O. C. Trautman** and appeared in the November, 1937 issue of **WIRE AND WIRE PRODUCTS.** The advantages attending the use of this method are quite apparent. From investigations thus far carried out, the results of which will be presented later, it appears that this new method holds considerable promise of being well suited to the Patenting of rope wire.

✦ ✦ ✦

IN the heat treatment of the 0.05%-0.25% carbon steel to be cold drawn into Iron Grade rope wire, considerable variation of method and practice will be found to exist among the various manufacturers. Probably the greatest quantity of this grade of wire is drawn from stock annealed at temperatures below the critical range from about 1050° F. to 1300° F. Such treatment results in a relatively soft material of low tensile strength whose grain structure consists of Ferrite and Spheroidized Iron Carbide. Other heat treatments to which this class of steel are subjected consist either of a full annealing at temperatures slightly in excess of the upper critical temperature or of a Normalizing at a temperature of about 1700° F. These latter treatments impart a higher tensile strength to the stock, remove completely all directional properties induced by previous cold drawing, and result in a grain structure consisting of Ferrite and normal Pearlite of varying degree of fineness.

✦ ✦ ✦

Preparation for Cold Drawing

REMOVAL of the scale formed upon the surface of rope wire stock during heat treatment is accomplished by the usual methods of acid pickling or cleaning. Either a sulfuric acid solution or a hydrochloric acid solution can be used. Both solutions will give satisfactory results if used in strengths varying from about 7% to 12%. The temperatures at which the solutions are maintained and operated vary from one manufacturer to another depending upon preferred practice. Temperature variations of from about 100° F. to 170° F. are common. Regardless of the kind of pickling solution employed, it is essential that it carry an efficient inhibitor in order to minimize the action of the acid on the steel itself and to reduce the danger resulting from over-pickling. To facilitate pickling, it is good practice to resort to means for providing continual or periodic motion to the immersed stock. After the pickling operation, the stock must be washed thoroughly in clear water so as to remove as completely as possible all traces of the pickling solution.

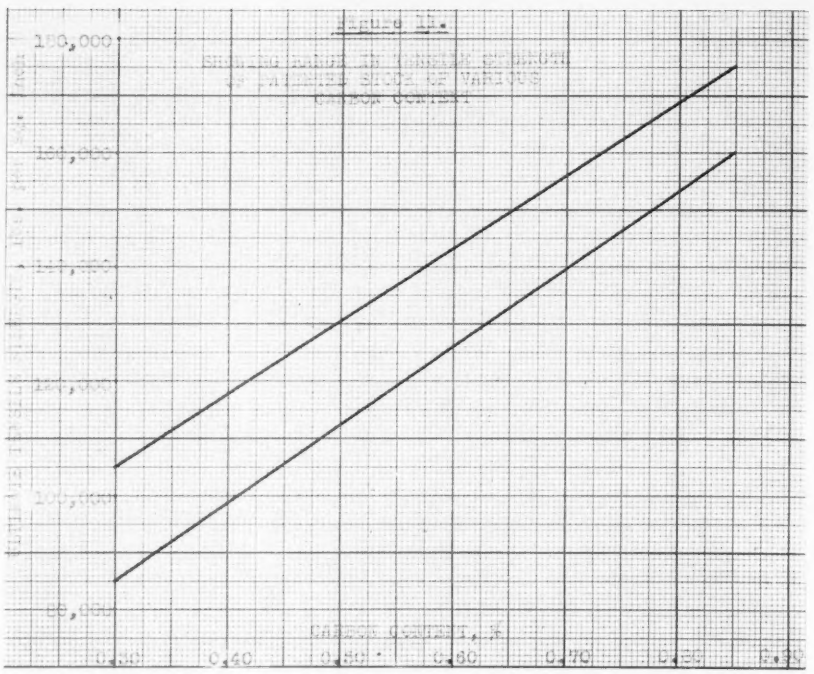

FIGURE 11.
Showing Range in Tensile Strength of Patented Stock of Various Carbon Content. ✦ ✦

✦ ✦ ✦

THE type of coating applied to the pickled surface of the steel is dependent upon the nature of the cold drawing process. Since most of the rope wire in use today is dry drawn, the stock is given a sull coat and, in some instances, a copper coat by immersion in an acidified solution of Copper Sulfate. The wet drawing process is employed by some manufacturers in the production of the finer sizes of rope wire. Following the application of the sull or copper coat, the stock is limed and subjected to the usual baking treatment after which it is ready for cold drawing into the finished rope wire.

✦ ✦ ✦

Cold Drawing

THE cold drawing of the wire may be conducted either by the intermittent, or single-hole, method or on a continuous machine. The continuous machine has many advantages and its use is to be preferred. The development of the carbide die and of means for cooling both die holder and wire drawing block, either by air or water, have in no small measure contributed to improvement of rope wire quality. The use of the carbide die aids materially in the production of wire of uniform diameter and smooth surface. Cooling of the die holder and drawing block keeps both the temperature at which deformation of the steel in the die takes place at a relatively constant figure and the temperature of the wire from rising to a point recognized as detrimental to physical properties and, also, allows for increase in drawing speeds. The usual range in speed employed in

Showing Grain Structures Typical of Iron Grade Rope Wire.

Magnifications of All Photomicrographs—200X. ✦ ✦ ✦ ✦ ✦ ✦ ✦ ✦ ✦

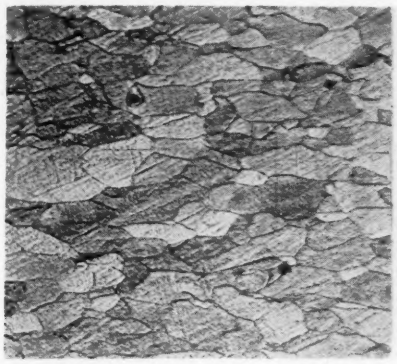

Figure 12.

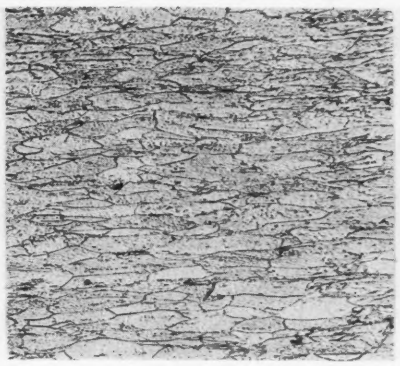

Figure 13.

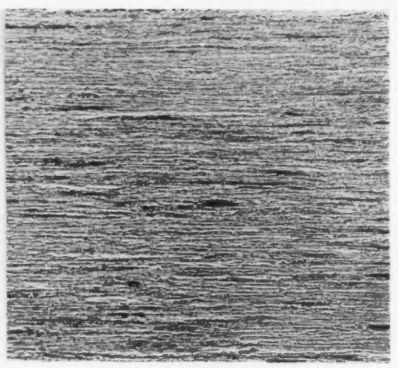

Figure 14.

Showing Grain Structures Typical of Improved Plow Steel Grade Rope Wire.

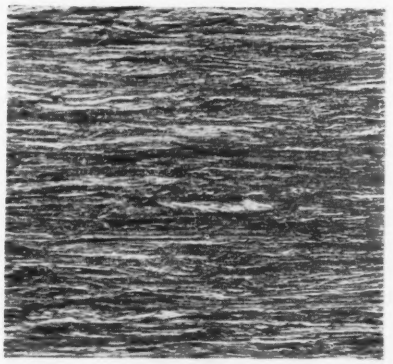

Figure 15.

Long Fibre Wire. Mag.—200X. ✦ ✦

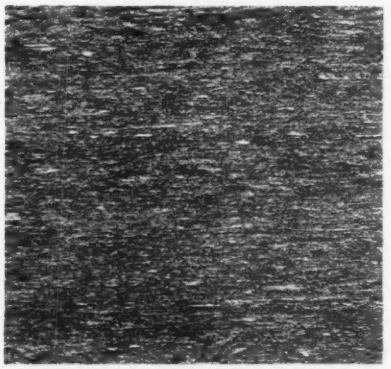

Figure 16.

Short Fibre Wire. Mag.—200X. ✦ ✦

finishing rope wire is between about 200 and 600 feet per minute, although speeds greater than 600 feet per minute can be and are used. While cooling is recognized as an aid to increase in die life, the greatest benefit derived from it lies in an improvement in the uniformity of physical properties of the drawn wire. Insofar as lubrication is concerned, the use of powdered soap in conjunction with the sull or copper and lime coating is quite satisfactory.

✦ ✦ ✦

IT has been stated that the usual total percentage of reduction in cross-sectional area which heat treated rope wire stock receives in being cold drawn to finished wire varies between 65% and 90%. The actual total percentage of reduction employed in drawing is determined largely by the physical properties it is desired to attain in the finished wire. Because practically identical physical properties can be imparted to a given wire by resorting to a number of different schemes of drafting, actual drafting practices of the various manufacturers are seldom, if ever, exactly the same. For a given total reduction, some will resort to uniformly medium drafts throughout the drawing and others will use uniformly light drafts. Further, combinations of heavy and medium, medium and light, and heavy and light drafts will be found in use. Whatever the practice be depends largely upon not only personal judgment but also upon the properties and serviceability obtained from a given wire drawn in one manner as compared with the properties and serviceability of a similar wire drawn in a different manner.

✦ ✦ ✦

Discussion of Properties

MICROSCOPIC examination of prepared longitudinal sections of rope wire reveals a structure exhibiting pronounced strain induced by cold work and possessing a more or less fibrous nature. The apparent fiber is dependent primarily upon the grain structure obtained in the heat treatment of the stock from which the wire was drawn and upon the extent and manner of drawing.

✦ ✦ ✦

THE photomicrographs, Figures 12, 13, 14, 15, and 16, illustrate microstructures typical of longitudinal sections of rope wire of Iron and Improved Plow Steel grades. The differences in structure of the Iron wire shown in Figures 12, 13, and 14 are, indeed, considerable although their existence is not uncommon. Figures 15 and 16 are of interest for they represent what are commonly referred to as long and short fiber wires. Further, they are photomicrographs of 0.0485″ diameter Improved Plow Steel wire cold drawn in the same manner from two different portions of the same coil of 0.128″ diameter, 0.67% Carbon, heat treated stock. In the case of the long fiber wire, the 0.128″ diameter stock was Patented in a conventional gas-fired furnace at a linear speed of 7 feet per minute and a temperature of 1780° F. followed by a quench in a molten salt bath held at 980° F. The Patenting of the 0.128″ diameter stock from which the short fiber wire was drawn was effected by the Electric Direct Resistance method. The linear speed was 28 feet per minute, the temperature was 1750°F. and the quench consisted of molten lead, the temperature of which was maintained at 950° F. A comparison of the physical properties of both the 0.128″ dia. heat treated stock and the finished wire are shown in

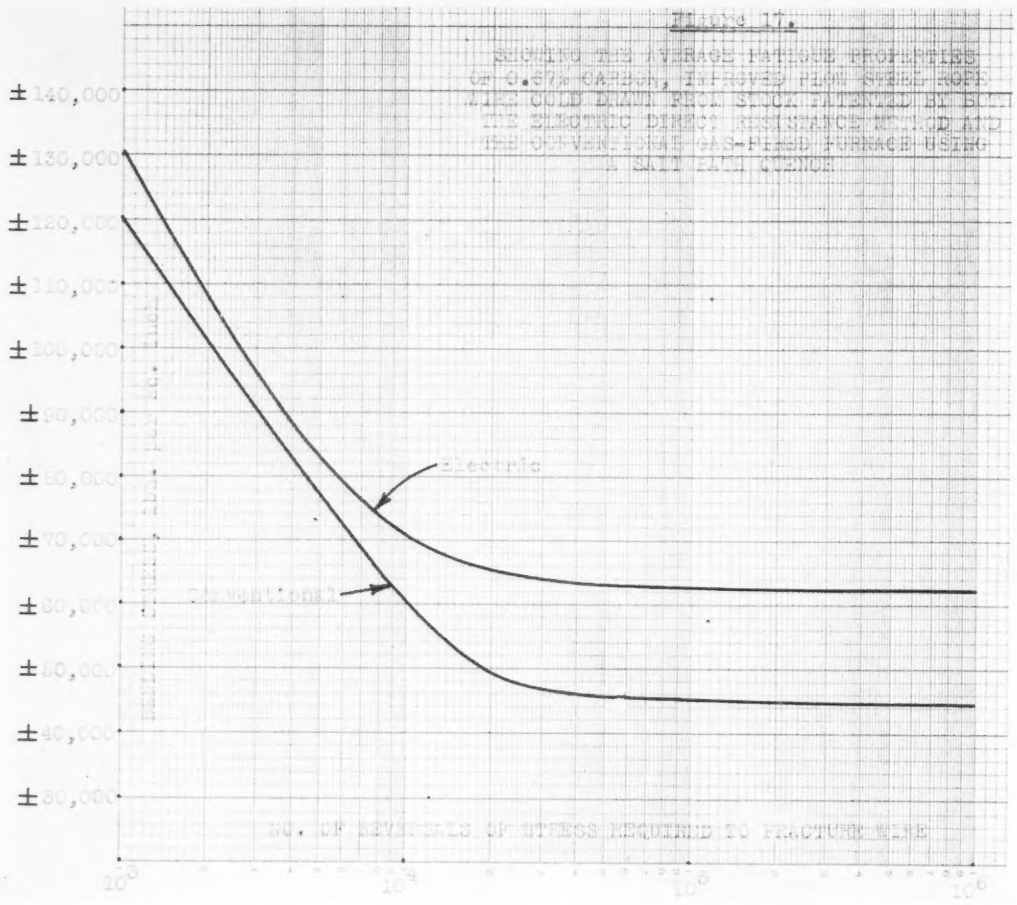

Figure 17.
Showing the Average Fatigue Properties of 0.67% Carbon, Improved Plow Steel Rope Wire Cold Drawn from Stock Patented by Both the Electric Direct Resistance Method and the Conventional Gas-Fired Furnace Using a Salt Bath Quench. ✦

Table III. The fatigue characteristics of the two wires are shown in Figure 17.

✦ ✦ ✦

THE size and construction of a wire rope and the construction of its strands determine the diameter to which rope wire must be drawn. Since there are many sizes and constructions of wire rope in use today, it becomes necessary to manufacture rope wire in various diameters ranging from about 0.007″ to 0.200″. A very important physical characteristic of rope wire is that it have uniform diameter throughout the length of a coil and that it be perfectly round and smooth of surface. Tolerances on variation from a specified diameter must be and are maintained at a low figure. Ability to maintain uniform diameter, perfect shape, and a smooth surface has been greatly enhanced by the introduction and use of the carbide die.

✦ ✦ ✦

THE various physical properties of rope wire, such as tensile strength, ductility and toughness, resistance to deformation or abra-

TABLE III.

Showing Physical Properties of 0.67% Carbon Steel Rope Wire Resulting From Patenting By Conventional and Electric Direct Resistance Methods

	Conventional Method	Electric Method
Ultimate Tensile Strength of 0.128″ Dia. Patented Stock, lbs. per sq. in.	146,200	164,000
Percentage Elongation on 10″ of Patented Stock	9.5	9.5
Percentage Reduction in Area at Fracture of Patented Stock	31.0	55.5
Ultimate Tensile Strength of Cold Drawn Wire, lbs. per sq. inch	257,500	287,500
Percentage Elongation on 10″ of Cold Drawn Wire	1.6	1.6
Torsions on 100 Diameters Obtained From Cold Drawn Wire	43.5	41.0
No. of 180° Reverse Bends Obtained From Cold Drawn Wire—		
4 mm. (0.157″) radius	24.5	26.0
6 mm. (0.236″) radius	43.0	44.0

sion, and resistance to fatigue, will be discussed only briefly in this paper. Each has been treated in quite a complete manner in the books entitled **"Wire Drawing And The Cold Working Of Steel"** by **A. T. Adam** and **"Steel Wire"** by **Maurice Bonzel.**

✦ ✦ ✦

GENERALLY speaking, it is the aim of the rope wire manufacturer to produce a wire from a given grade of steel in such a manner that the necessary tensile strength is obtained without undue sacrifice of the other properties. The actual properties which a rope wire should possess are governed in a large measure by careful consideration of the conditions of service to which the fabricated wire rope is to be subjected. For this reason, an appreciable variation in the tensile strength of wire of the same grade is quite common. This is particularly true in the case of the Improved Plow Steel grade and, to some extent, in the Iron grade.

✦ ✦ ✦

REFERRING to the tensile values shown in Table I, these are recognized as minimum and are required of the wire after its removal from the fabricated rope. Actually, the tensile strength of Iron grade will vary from 70,000 lbs. per sq. inch to 150,000 lbs. per sq. inch. Traction Steel, Cast Steel, and Mild Plow or Extra Strong Cast Steel grades will be found to have tensile strengths ranging from the minimum shown to a value 30,000 to 40,000 lbs. per sq. inch in excess of this minimum. Plow Steel grade usually varies in tensile strength from 210,000 lbs. per sq. inch to 240,000 lbs. per sq. inch. The Improved Plow Steel grade of rope wire is drawn to a number of different ranges of tensile strength between about 210,000 lbs. per sq. inch and 350,000 lbs. sq. inch. However, most of the wire of this grade has a tensile strength within the range 240,000 to 280,000 lbs. per sq. inch.

✦ ✦ ✦

WITH possibly no exceptions, all grades of rope wire are required to exhibit in a certain degree resistance to fracture upon continual twisting. The number of twists through 360° required to fracture a specimen of wire whose length is usually 100 times its diameter is commonly designated as the number of torsions on 100 diameters obtained from the wire. The number of torsions on 100 diameters which the various grades of wire must withstand upon their removal from a wire rope is frequently specified. The **Federal Specification for Wire Rope, RR-R-571,** states that the minimum number of torsions for Improved Plow Steel grade must be 25.0, for Plow Steel 27.5, for Mild Plow or Extra Strong Cast Steel 30.0, for Cast Steel and Traction Steel 32.5, and for Iron grade 40.0. The torsion test is considered a means for checking toughness and ductility and for detecting surface or internal defects in the wire. Its importance and significance can be and frequently are overemphasized. Fortunately, it is not particularly difficult to obtain at least 35 or 40 torsions on 100 diameters from all grades of rope wire cold drawn from properly Patented and prepared stock.

✦ ✦ ✦

THE total elongation obtained from wire in conducting a simple tensile test is often regarded, also, as a measure of ductility. This elongation, or stretch, is customarily expressed as a percentage of an original gage length of 10 inches. The percentage elongation on 10″ required of rope wire, if and when specified, ranges from about 1% to 4% depending primarily upon the diameter of the wire. As the diameter of the wire increases, the percentage elongation obtainable increases.

✦ ✦ ✦

ALTHOUGH seldom, if ever, specified, the figure for percentage reduction in cross-sectional area at fracture resulting from tensile loading is a good index of ductility and toughness. Its use, however, is limited to the larger sizes of wire because of the difficulty encountered in accurately measuring the diameter at fracture of the smaller sizes.

THE bend test as applied to rope wire for measuring ductility is of value only from the standpoint of obtaining a comparison of the bending properties of two or more wires of the same diameter and grade which have been processed either from different material or in a different manner. This fact is quite generally recognized as being true. Further, factors pertaining to conditions and methods of test are very difficult to control and to maintain constant. The result is that tests are obtained which often show considerable variation and are not thoroughly reliable. Attempts to correlate bend test results with actual service data on rope wire have not met with any appreciable degree of success.

✦ ✦ ✦

RESISTANCE of rope wire to failure through fatigue represents in itself a very interesting and comprehensive study. Satisfactory equipment for obtaining the endurance characteristics of rope wire under reversed bending conditions has been available for only a relatively short period of time. During this time, extensive investigations have been conducted which have yielded some valuable data and information. There are a great many factors known to influence the magnitude of fatigue and endurance values resulting from conducting fatigue tests on wire in air. Among these are composition and heat treatment, manner and extent of cold working, surface decarburization, smoothness of surface, and, possibly, **McQuaid-Ehn** grain size. After the wire is fabricated into rope, however, it is frequently subjected to a number of forces, such as corrosion and crushing or bruising, which are inevitable, beyond control, and of such a nature as to aid in bringing about early fatigue failure. While it seems desirable to impart to rope wire the highest possible fatigue limit and the greatest endurance at stresses above the fatigue limit, the author feels that much work involving correlation of normal fatigue properties with performance records remains to be done be-

(Please turn to Page 617)

THE WORLD'S LARGEST MAKERS OF SPRING MACHINERY ENDORSE

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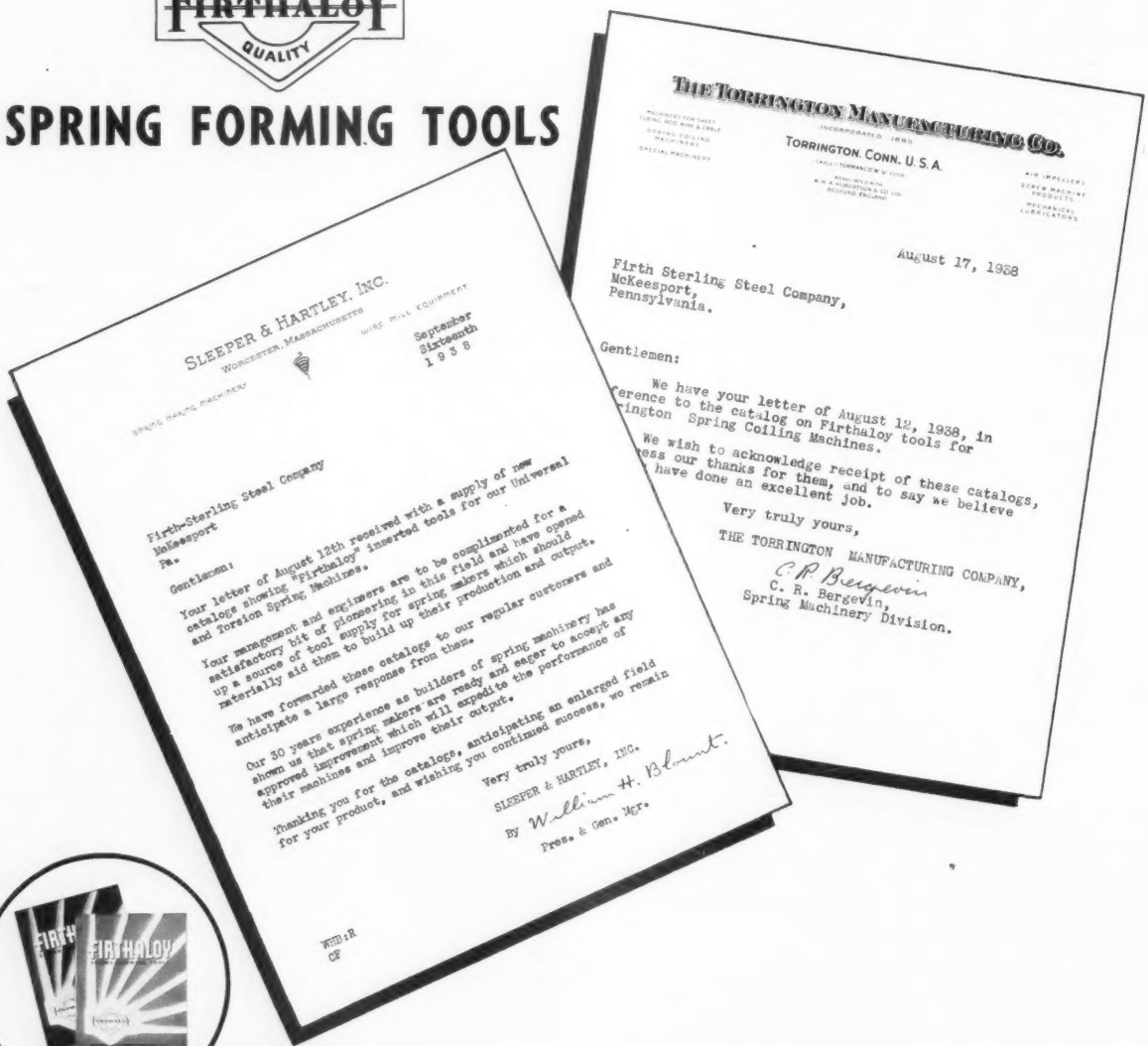

THE TORRINGTON MANUFACTURING CO.
TORRINGTON, CONN. U. S. A.

August 17, 1938

Firth Sterling Steel Company,
McKeesport,
Pennsylvania.

Gentlemen:

We have your letter of August 12, 1938, in ference to the catalog on Firthaloy tools for rington Spring Coiling Machines.

We wish to acknowledge receipt of these catalogs, ess our thanks for them, and to say we believe have done an excellent job.

Very truly yours,

THE TORRINGTON MANUFACTURING COMPANY,
C. R. Bergevin
C. R. Bergevin,
Spring Machinery Division.

SLEEPER & HARTLEY, INC.
WORCESTER, MASSACHUSETTS
WIRE MILL EQUIPMENT
SPRING MAKING MACHINERY

September Sixteenth 1938

Firth-Sterling Steel Company
McKeesport
Pa.

Gentlemen:

Your letter of August 12th received with a supply of new catalogs showing "Firthaloy" inserted tools for our Universal and Torsion Spring Machines.

Your management and engineers are to be complimented for a satisfactory bit of pioneering in this field and have opened up a source of tool supply for spring makers which should materially aid them to build up their production and output.

We have forwarded these catalogs to our regular customers and anticipate a large response from them.

Our 30 years experience as builders of spring machinery has shown us that spring makers are ready and eager to accept any approved improvement which will expedite the performance of their machines and improve their output.

Thanking you for the catalogs, anticipating an enlarged field for your product, and wishing you continued success, we remain

Very truly yours,
SLEEPER & HARTLEY, INC.
By William H. Blount
Pres. & Gen. Mgr.

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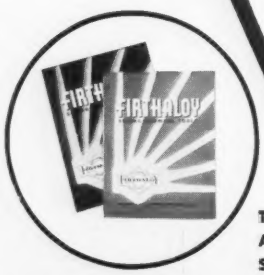
CF



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NEW YORK CHICAGO
HARTFORD PHILADELPHIA
LOS ANGELES DETROIT
CLEVELAND DAYTON
GLOBE WIRE DIVISION
McKEESPORT, PA.

Stainless Steel Wire

By J. K. Findley,
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In this discussion it will be attempted to cover only the present major uses of stainless steel wire, some of the factors involved in the selection of the types of stainless that will best meet the requirements of the applications, and a brief outline of methods of processing some of these wires. ✦ ✦ ✦ ✦

DURING the last decade the demand for stainless wire has grown steadily. Within this time most of the existing possible applications where large quantities of this type of wire could be used, should have been uncovered. The future will unquestionably bring along newer compositions or processing methods that will make possible the use of stainless wire in large quantities on some of these applications where only a small portion of the tonnage used is stainless. Any mention of what these analyses or methods of processing might be would be, at best, untimely, therefore we will concern ourselves only with what we have to date.

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Products of Stainless Steel Wire

THE first demand for stainless steel in wire form came from the necessity of having material of similar composition for the welding rods, bolts, nuts, screws, rivets and nails used in fabricating the various equipment made from stainless plates, sheets and bars. This was followed by the use of stainless steel wire in the making of many wire products where the advantage of longer life offset its higher initial cost. Among such products are

Wire cloth used in the paper and chemical industries
Woven wire conveyor belts for brazing and annealing furnaces
Springs operating in corrosive atmospheres or at elevated temperatures
Wire rope on ocean-going yachts
Aircraft cord for coastal and seaplanes
Bacon hangers and sausage molds used in the handling of meat
Metal sponges for cleaning dairy equipment
Fishing leaders and lines for salt water fishing
Ligature wire
Radio antennae
Steering wheel spokes for automobiles
Armature banding wire for electric motors.

Wire for Welding Rods, Bolts, Nuts, Screws and Rivets

IN selecting material to be used for welding rods, bolts, nuts, screws and rivets, it is usually desirable to use wire of approximately the same analysis as the material to be fabricated. For the austenitic chrome-nickel type of welding rod, titanium or columbium may be included in the analysis to prevent excessive carbide precipitation. Neither the low carbon straight chromium nor the austenitic chrome-nickel wire has given great difficulty in cold heading operations.

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J. K. FINDLEY

Born in Butler, Pa., in 1899; educated in the Butler public schools and Rensselaer Polytechnic Institute, Troy, N. Y.; chemist at Jones & Laughlin Steel Corp., Pittsburgh, 1922 to 1924; chemist at Atlas Steel Corp., Dunkirk, N. Y., 1925 to 1929; 1929 to present time—metallurgical department as metallurgist on stainless steel in the same plant, which was subsequently merged with Ludlum Steel Co., and is now Allegheny Ludlum Steel Corp.

MOST of the heading is done in closed dies, so the wire is supplied with a lubricating coating drawn onto the wire. Copper, lime and soap, or an oxidized coating may be used. In the 18-8 type of cold heading wire it has been advantageous to keep the nickel on the high side to minimize the work-hardening effect of the skin pass used in drawing on the lubricating coating and the subsequent heading operation. For cut thread work, free-machining varieties in which sulphur or selenium has been added to the metals are available in both the straight chromium and 18-8 types of cold heading wire.

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Wire for Weaving Wire Cloth, Screens and Conveyor Belts

IT would be fairly conservative to state that at least one-half of the stainless wire now produced in sizes under 3/32″ rd. is used in weaving wire cloth, screens, and conveyor belts. Wire cloth used in paper mill equipment accounts for a large part of this quantity. Failure to withstand the repeated flexing that Fourdrinier wires are subjected to for a long enough period to justify its initial cost has kept, up to the present time, stainless wire cloth out of the attractive market of Fourdrinier wires. Where the cloth is not subjected to such flexing, stainless wire has been used with much success. Practically all of the stainless used on these applications is either 18-8, or 18-8 with about 2.50 to 3.00% molybdenum. A typical analysis of the 18-8 would be: Carbon .07%, chromium 18.25%, nickel 8.75%. For the 18-8 with molybdenum, a typical analysis would be: Carbon .07%, chromium 18.25%, nickel 11.00%, molybdenum 2.75%. The latter analysis gives better resistance to attack in sulphite liquors,

where temperatures of the liquors are higher than normal; also in liquors where the hydrochloric acid concentrations may rise as high as 4%.

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FOR most meshes that are woven it is highly desirable to have the stainless wire in the dead soft annealed condition. At their softest, these austenitic chrome-nickel stainless wires are considerably stronger and livelier than the bronzes or brasses generally woven, and require more power to weave. The tensile strength on these stainless weaving wires will run from 100,000 to 120,000 pounds per square inch, averaging 105,000 pounds, and will show elongation in 10-inch guage lengths varying from 40 to 70%, averaging 50%. It is best to use stainless foundation or winding wires in conjunction with the stainless wire cloths. These winding wires are of the same analyses as listed above; however, their tensile and yield strengths are increased slightly to allow for uniform winding without stretching or creating flat spots.

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WOVEN wire belts for carrying material continuously through furnaces are made from several types of stainless wire. The analysis of the wire applied depends entirely upon the atmosphere or temperature in the furnace. Belts operating at temperatures less than 1000°F. are often made from the low-carbon 16.00 to 18.00% chromium steels, but for temperatures over this and up to approximately 1400°F., the 18-8 type is recommended. For temperatures over 1400°F. and up to 1900°F., either 25.00% chromium, 12.00% nickel, or 25.00% chromium, 20.00% nickel is recommended. Strength as well as scaling resistance at these temperatures is an important factor in the life of these belts, hence the recommendation of the above types. For example, a 27.00% straight chromium steel would offer as much scaling resistance as the 25.00% chromium, 20.00% nickel at a temperature of 1900°F.; however, the strength of the straight chrome would hardly be a third of the strength of the 25-20 chrome-nickel at this temperature. For weaving these belts it is desirable to have the wire in the dead soft annealed condition.

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Wire for Wire Rope and Springs

THE quite definite rate at which the 18.00% chrome, 8.00% nickel stainless work-hardens in cold drawing is responsible for the use of this alloy in making stainless wire rope and springs. This work-hardened wire has somewhat less resistance to corrosion in some solutions or atmospheres than in the annealed condition; however, its resistance to corrosion in salt water or salt air is unimpaired. A good many thousands of feet of stainless wire rope are now on ocean-going yachts, including some of the boats which have sailed in some of the well-known races. Quite a little aircraft cord made from stainless steel wire is in use on planes flying along the seacoasts.

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Rope Wire

THE analysis of the 18-8 alloy used in making these wires is held within a fairly narrow range to keep the physicals of the cold drawn wire as uniform as possible. Some of the characteristics desired, particularly the endurance against fatigue in bending demanded on aircraft control cord, have been found to depend on inherent characteristics of the melt. These inherent characteristics are independent of the analysis or methods of processing the wire. For this reason selective melts are chosen for aircraft control cord wire or other rope wire where the finished wire rope must meet difficult fatigue requirements.

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WHEN annealed wire of the 18-8 alloy type is cold drawn through successively smaller dies and the percentage reduction of cross sectional area of the wire is plotted against the increasing tensile strength, the resultant is a fairly right line. Taking the junction of the coordinates of 0% reduction of area and 105,000 PSI tensile, the plotted curve will show that 75% reduction in cross sectional area gives an average of 245,000 PSI tensile, and 91% reduction in area gives approximately 300,000 PSI tensile. 75% reduction in area is equivalent to drawing the wire to half its original diameter, and 91% is equivalent to a reduction to less than one-third of the original diameter. From a large number of determinations it has been possible to establish the possible plus or minus variation from a theoretical tensile which should be obtained with a certain percentage of draft on the wire. Charts have been made which will show the correct size of annealed wire to draw from in order to get a desired tensile on any given size of finished wire. Rope wire tensiles run from about 340,000 plus or minus 15,000 PSI on .007" rd. wire, down to 250,000 plus or minus 12,000 PSI on .100" rd. wire.

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Spring Wire

THE use of stainless steel wire in corrosion and heat resisting springs has been growing continually. Most of this has been the 18-8 alloy; however, 12-2 chrome-nickel alloy has been used with success in many instances. The 18-8 spring wire is made in the same manner as 18-8 rope wire. The tensile strengths of corresponding sizes of rope and spring wire are nearly the same. Efforts are made to keep the variation of physical properties on any size within the narrowest practical range. The modulus of torsion averages about 10,500,000 but may vary from 9,000,000 to 11,000,000 lbs. The 12-2 chrome-nickel type is made by heat-treating the wire to obtain a tensile of approximately 190,000 PSI, then cold drawing to further increase the tensile to the desired figure. The modulus of torsion on this type of spring wire does not vary as much as on the 18-8 type. This is an advantage in some cases; however, this 12-2 type does not give as high a resistance to corrosion as the 18-8 type. The maximum operating temperature recommended for 18-8 springs which must maintain great accuracy is 350°F.; however, many of these springs are operated at temperatures far higher than this and maintain fair spring properties.

For most uses it is recommended that these 18-8 springs be baked at a temperature of 400 to 600°F. after coiling to get permanent set or dimensions.

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IF the springs are to be mandrel-wound it is not necessary to have a coating on the wire; however, if they are formed on automatic coiling machines, practically all spring makers have found it decidedly advantageous to have a coating on the wire. This may be either a thin layer of a soft metal or an oxide coating. This wire for automatic coiling must also be "cast flat".

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Wire for Fishing Leaders

EXCELLENT fishing leaders for salt water fishing are made from 18-8 type wire. These leaders may be either single wire or stranded wires. For single wire leaders the wire must be entirely free from cast — that is, almost perfectly straight. The tensile strengths of the wires for this use are approximately that of rope or spring wire.

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THE fact that the analysis and processing can be controlled closely enough to give an 18-8 type wire that has a tensile strength of approximately 220,000 PSI an elastic limit of over 135,000 PSI, and at the same time remain practically non-magnetic, has made this material an excellent wire for banding electric motor armatures.

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Metal Sponges

WHILE fair quantities of the straight 12 to 14% or 16 to 18% chromium wire are used for cold headed products, there have not been the number of applications for these wires in the so-called fine sizes that there are for the chrome-nickel types of stainless. There is, however, one application for fine wire of the 16 to 18% chromium, or our "RA" (chrome-copper-silicon) type, and that is for making stainless metal sponges for dairy and household use. Wires approximately .005" rd. are flattened, curled, and woven together in such a manner as to make a very convenient sponge that gives long life without breaking up.

Wire for Bacon Hangers and Sausage Molds

BACON hangers and sausage molds have accounted for the use of desirable quantities of a medium temper, bright drawn 18-8 type stainless wire. Automobile aerials and steering wheel spokes have taken a good many tons of both the 18-8 and 12-2 types of stainless in the form of wire that has been cold drawn to full hard temper, straightened, cut and polished. Almost numberless other uses for stainless wire could be mentioned but it might be well to move along to the general methods of processing stainless wire.

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The Processing of Stainless Steel Wires

A FEW years ago we considered stainless wire, particularly the austenitic chrome-nickel types, very difficult to process in wire mills. Furnaces had to be built that operated usefully at 2000°F. to anneal the chrome-nickel alloys. Pickling solutions had to be changed to get the wire free from scale without pitting after annealing, and worst of all, the wire did not readily take any kind of coating which would facilitate cold drawing without scratching the wire, or breaking out the dies. Gradually the most troublesome of these problems were solved, and while stainless is still a comparatively expensive wire to draw, it can be drawn without much difficulty. Various types of coatings have been used with success, including copper, lead or lead alloy, and oxide coating. This oxide coating was developed at our Dunkirk mill and we have found it very economical and successful. The method of application to the wire has been more or less a mill secret ever since it was first used in 1929.

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ON receiving the hot rolled rod from the hot mills, it is annealed at approximately 1900° F. for most of the 18-8 types, or 1500° F. for most of the straight chromes. The furnaces used are either gas-fired or electrically heated. On the 18-8 types the rod is brought to temperature rather rapidly and is left at temperature just long enough to insure thorough soaking of the heat through the wire, and is then removed from the furnace and quenched in water. On the straight chromes it is more desirable to heat the rod a little slower and to give it a slow cool after soaking at temperature. The rods are then cleaned free from scale and coated to draw. Tungsten carbide dies are becoming more and more popular in the cold drawing operation. The amount these rods are cold drawn before the next anneal depends to a large extent upon the type of drawing equipment available. The stiffness due to work-hardening makes it economical in a number of cases to reanneal after about 65% reduction of cross sectional area. The processing annealing temperatures are often 100 to 200° F. lower than the first anneal, if the material is to have a subsequent full anneal.

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Continuous Strand Annealing

CONTINUOUS strand annealing under pure hydrogen atmosphere is becoming more prevalent on the intermediate anneals as well as on the final anneals. We have found it to be a distinct advantage to process anneal as well as final anneal all sizes under approximately .100" rd. in our strand annealing furnaces. In drawing sizes approximately 1/16" rd. and smaller we use slip-ring type multiple drawing machines. Speed of drawing may vary from 100 to 200 feet a minute, depending entirely upon the type of finish or temper to which the wire is being drawn. On the finer sizes, .005" for instance, speeds of 300 to 500 feet per minute are customary.

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IN conclusion, I wish to admit that the discussion on any one of the aforementioned applications or processings has been brief, but it will be quickly realized that completely to cover any one of these subjects would be a discussion—and not a short one—in itself.

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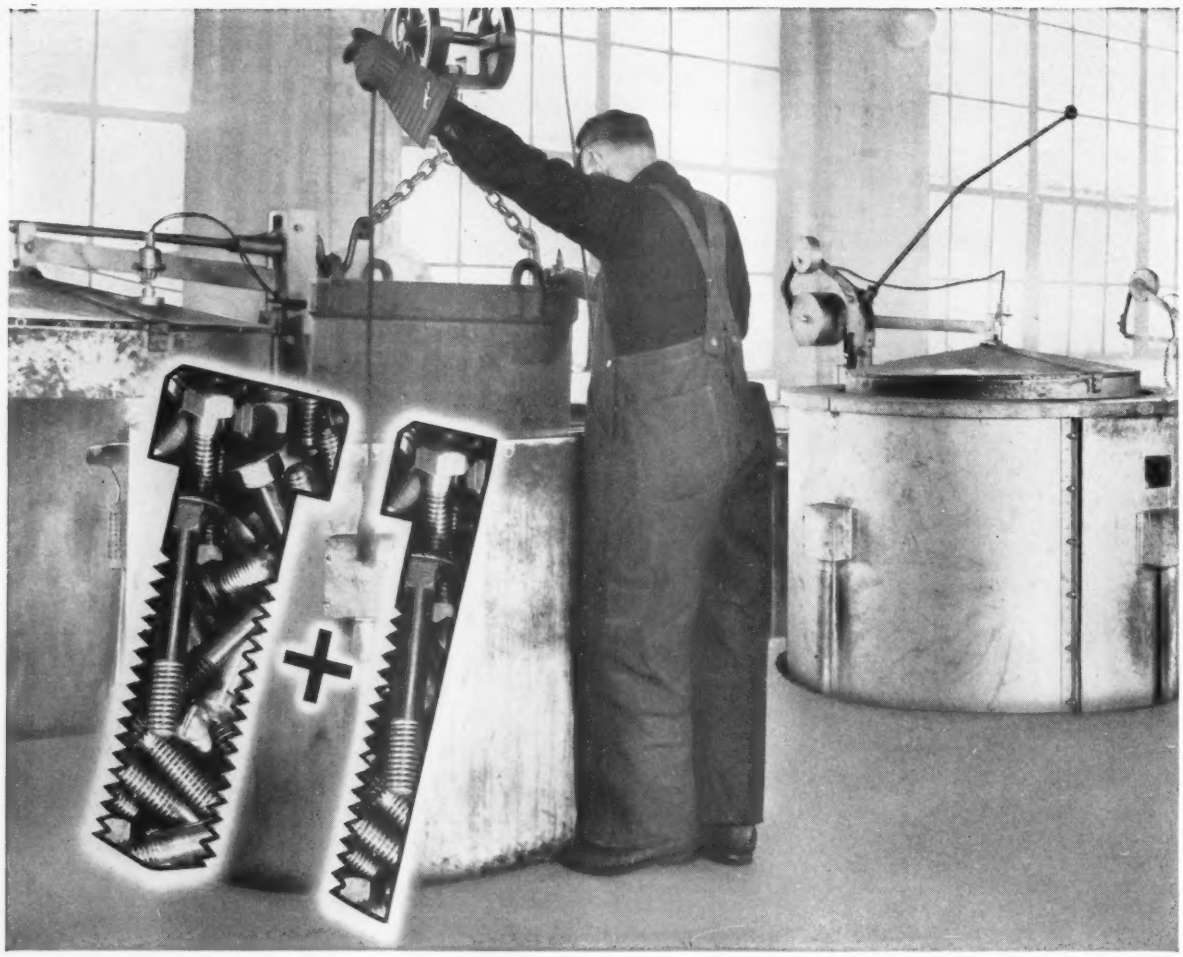
Acknowledgement:

The author wishes to express his appreciation to Mr. Frank B. Lounsberry, Vice President of Allegheny Ludlum Steel Corporation, for his counsel and permission to publish the above data.



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COLD WORKING OF METALS FINISHED PRODUCTS

Cold Worked Metals + + + Cold Formed or Machined Products + + + Cold Heading

1. Metallurgy and Research
2. Processes and Machinery of Production
3. Cold Heading
4. Cold Forming and Finishing Operations
5. Extruding

Vol. 13 OCTOBER, 1938 No. 10

Some Characteristics of Wire and Their Relation to Cold Heading

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In view of the fact that the success of the extrusion process depends very largely on the type of surface finish on the wire, the study presented here should be of material assistance to the industry. + +

THE cold heading art is fairly well understood and a great deal has been written regarding standard cold heading practices. The bolt industry was limited for a considerable length of time because of the absence of suitable raw material and a lack of tool steel and design capable of withstanding extreme pressures necessary to plastically deform the material. In recent years, rapid progress has been made. It is now common practice to upset relatively high carbon and alloy steels. The demand for close tolerances and a scale free product placed it in a favorable position as compared to hot heading. The economy of cold heading over the turning process further extended the field.

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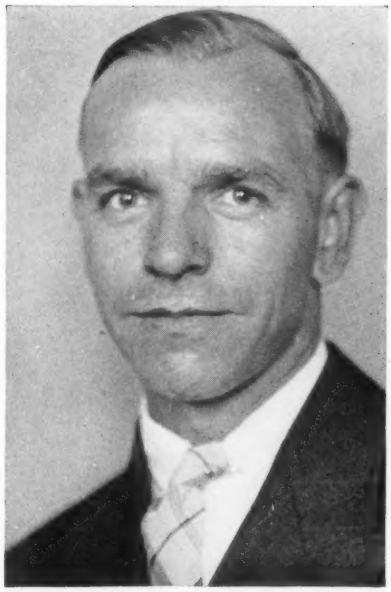
A NUMBER of articles have recently been presented which cover many of the important phases of the cold heading industry. An attempt is herein made to fill in and stress a number of points which have not been entirely cleared up. Adding these comments to the articles mentioned in the reference table should give a very comprehensive insight into the practices of the cold heading industry.



HOWARD L. HOPKINS

Graduated from Case School of Applied Science 1930; Alloy development at Aluminum Company of America Research Laboratories 1930-1935; Metallurgist for The National Screw & Manufacturing Company, Cleveland, Ohio, 1935 to-date. Member of The Wire Association, The American Society for Metals.

A VERY thorough appraisal of the principles of cold heading and particularly the operation of heading machinery has been adequately presented by **Mr. Frank J. Oliver** (1). **Mr. C. L. Harvey** (2) has covered a comprehensive list of ferrous materials which have been successfully cold headed. The importance of a desirable metallographic structure in producing a material most suitable for cold heading was given thorough consideration by **Mr. H. B. Pulsifer** (3).

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SOME of the characteristics of cold heading wire were presented before this society last year by **Mr. A. M. Reeder** (4). He very admirably acquainted us with the necessity of co-operation between the raw material supplier and the fabricating plant. It might also be mentioned that this is becoming more important with the extensive use of single and double extrusion work, and the great variety of intricately shaped pieces now being formed.

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THE demands made by bolt consumers are becoming more severe with each passing day and this is particularly true of the

automotive trade. As a result the fabricating plants must have higher quality cold heading material. The material must, because of the nature of the operation, be extremely ductile and malleable. The fundamentals of the cold heading operation demand a material extremely free from segregation, pipes, laps, seams and all other surface imperfections. Raw material specifications frequently include type of metallographic structure, grain size control and nature of the surface finish. These requirements are forcing the steel producers to the limit, but they are made because of the necessity of keeping plant efficiency high even though extreme upsets are being made.

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Wire Finish

THE type of surface finish on the wire has been given only moderate consideration. In view of the fact, that the success of the extrusion process depends on the finish as much as other wire characteristics, it seems advisable to give it our immediate attention.

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THE type of heading operation governs the lubricating qualities of the wire finish. One type of finish may be suitable for common solid die work, but offer very little assistance to extrusion work. Open die work requires very little coating since slip between the stock and die is very small. The dies open and allow the finished blank to be kicked out without being under pressure.

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IN common solid die work, the stock size is usually 2 to 4 thousandths of an inch smaller in diameter than the hole in the die. During heading, the material swells to the die size. The principle slip between the die and stock occurs when the blank is kicked-out, and at that time, the pressure is relatively low. Very little lubricant is necessary to prevent intimate contact between the die and the stock. Figure 1, gives an illustration of the upset blank as compared with the cut-off stock.

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IN the extrusion process the wire size is reduced by its being forced through a restricted opening. This process differs from wire drawing only in that a short length of wire is pushed through a die rather than being pulled through. Extreme pressures are necessary and slip occurs between the die and wire the full length of the extrusion. Slip also takes place over the entire extruded surface when the blank is kicked out and the pressure is rather high. The illustration in figure 2, shows a single extruded blank compared to the cut-off.

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A RELATIVELY good lubricant is required to prevent seizing. If the coating breaks down small particles of wire adheres to the extrusion bearing surface in the die and the surface of the blanks show numerous longitudinal scratches.

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A MORE substantial lubricant is required for the double extrusion process than the single extrusion process. The amount of slippage between the die and the wire is roughly twice that which occurs in the single process. The single extruded blank is again further reduced by being forced through an opening of still smaller cross section. Figure 3, shows the two reductions in the double extrusion process of making a cap screw.

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THE type of finish required for open die and solid die work has been produced by drawing the wire through soap, grease or one of the well known lime-stearate combinations. There is a wide difference of opinion as to the proper coating for single and double extrusion work. In any event, a medium coating is required for single extrusion work and a heavy coating for double extrusion work.

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ONE which has proven very satisfactory consists of drawing the limed rods through a pulverized mixture of two parts lime, one part aluminum stearate and one part calcium stearate. When properly applied, this finish has proven in test and production to be superior to the so called sull coating and equal to the best of the other common lime coatings.

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Preparation of Wire Rod

EVEN though the preparation of wire rod for drawing is common practice, it seems advisable to further stress its importance. Suc-

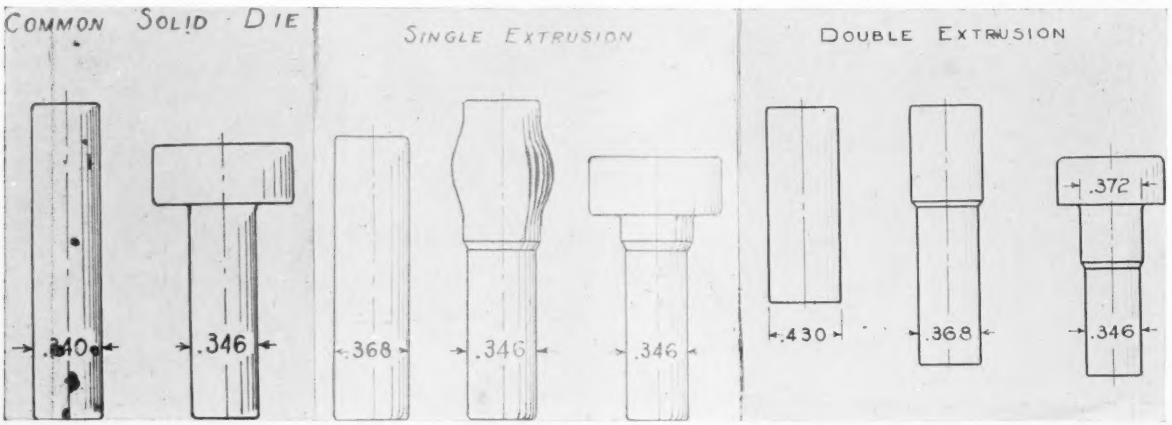

Figure 1. Cut-off and upset blank made in common solid header die.

Figure 2. Cut-off, extrusion and headed blank made by single extrusion process. ✦

Figure 3. Cut-off, first extrusion and headed blank made by double extrusion process. ✦

cessful operation of the header department depends so much on the raw material that it cannot be taken too lightly.

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ROD pickling is done primarily to remove rust, mill scale and other surface contaminations. Fortunately, the heterogeneous structure of the rod does not permit uniform solution of the metal. As a result, pits, valleys and other surface irregularities are formed. Figure 4, illustrates the rough surface on correctly pickled rod. The lime dip when correctly applied fills the pits and covers the entire surface with an adherent lime film. When the rod is drawn through the die, the lime is folded into the pits leaving a surface finish anchored or keyed to the rod by means of the partially closed pits. The illustration in Figure 4, shows the steps necessary to properly prepare wire for extrusion heading. This type of coating offers excellent lubrication for single or double extrusion work.

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A GOOD hard finish can be produced only if sufficient drafting is taken to pull the lime into the wire. Common practice on plain carbon steel is to reduce the diameter of the rod by one thirty second of an inch. On the other hand, some rod has been reduced by .020 inch and found to give satisfactory results.

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COLD heading complex shapes such as shoulder bolts also offer interesting problems. If the lime coating tends to rub off, it will pack in the corners of the die and the shoulder on the blank will not be completely filled out. Figure 5, illustrates this condition. This particular bolt was made from .425 inch stock. The portion to be threaded was extruded to .402 inch and the shoulder and head were upset to .540 and .750 inches diameter, respectively. In this case, the lime was scraped off in the extruding operation and packed in the anular shoulder in the die.

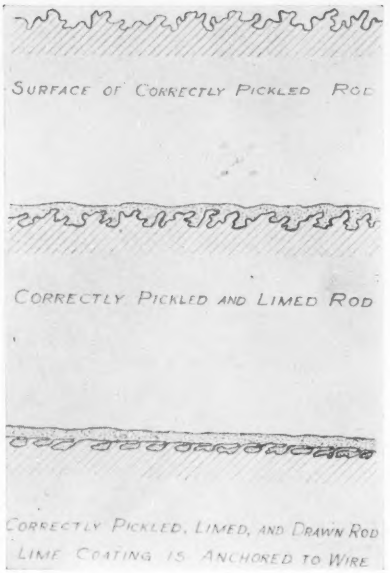
Surface of Correctly Pickled Rod
Correctly Pickled and Limed Rod
Correctly Pickled, Limed, and Drawn Rod
Lime Coating is Anchored to Wire

Figure 4. Illustration of steps necessary to properly prepare lime coating on header wire.

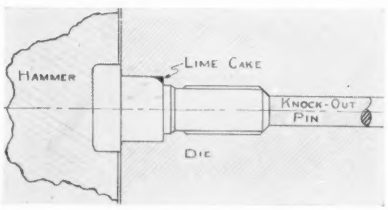

Figure 5. Lime cake in die recess. Lime was scraped off wire in extruding, packed in corner of shoulder recess and prevented blank from being completely filled out.

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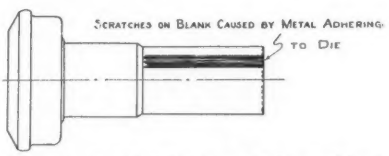

Figure 6. Scratched blank caused by particles of wire adhering to extrusion surface in header die.

IF the lime coating is thin or flakes off, it has very poor lubricating properties, particularly for double extrusion work. Particles of metal stick to the die and the resulting blanks show pronounced longitudinal scratches on the extruded surface, as shown in Figure 6.

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THE lime-stearate coating has certain disadvantages, in that, the ultimate finish is not as desirable as that produced from soap or grease drawn wire. It is also difficult to properly prepare the surface finish for plating. Articles made for decorative effects and finish matching should be avoided as far as possible.

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Physical Characteristics of Wire

THE heading operation consists of stressing the metal until a desirable plastic deformation has taken place. The characteristics of the wire between the yield and point of rupture are directly related to the upsetting process. A fairly accurate estimation of the cold working properties can be obtained from tensile results particularly yield strength, ultimate tensile strength and reduction in area.

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THE data listed in Table 1, was taken on SAE 1035 hot rolled rod .374″ diameter of the following chemical analysis:

Carbon	**.39%**
Manganese	**.72%**
Phosphorus	**.016%**
Sulphur	**.018%**
Silicon	**.145%**

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THE hot rolled rod was normalized at 1650° F. and drawn in production quantities as shown. It was necessary to reduce the rod to .353″ diameter, 11% reduction, in order to produce a satisfactory finish for extrusion heading. The normalized rod was given varying degrees of draft in order to establish the range of drafting suitable for heading wire.

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THE wire headed very satisfactorily after being drawn to .337″ diameter, 19% reduction. When it was reduced 26% to wire .322″ diameter, hardness cracks developed in the sides of the blank heads and header die life was materially lowered. It was quite apparent, that the wire drawing limits could be established at 10 to 20% reduction by cold drawing for this particular heat of steel.

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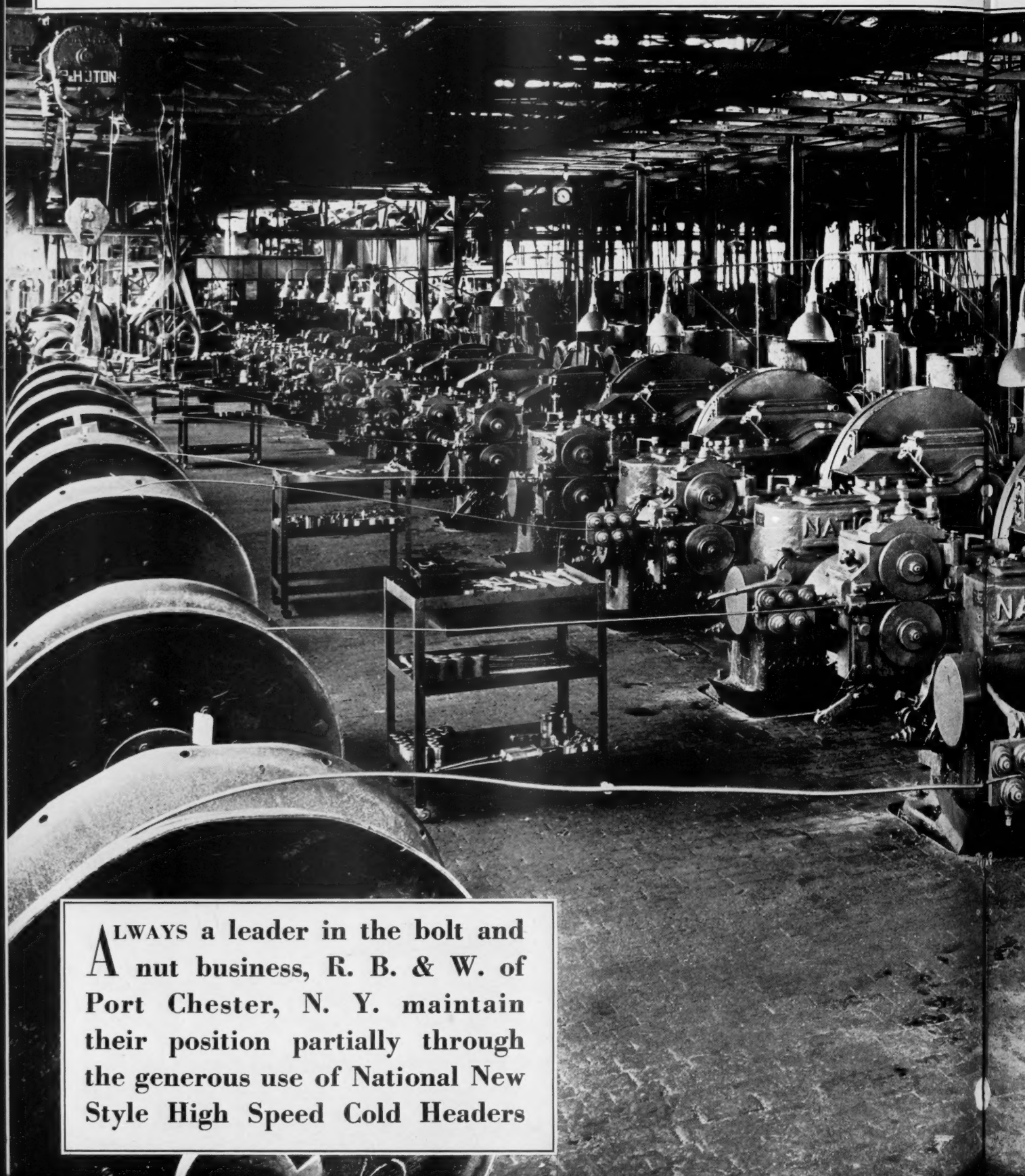
AS mentioned before, the cold heading operation consists of stressing the wire to a point greater than the elastic limit, so that,

PROGRESS *by*



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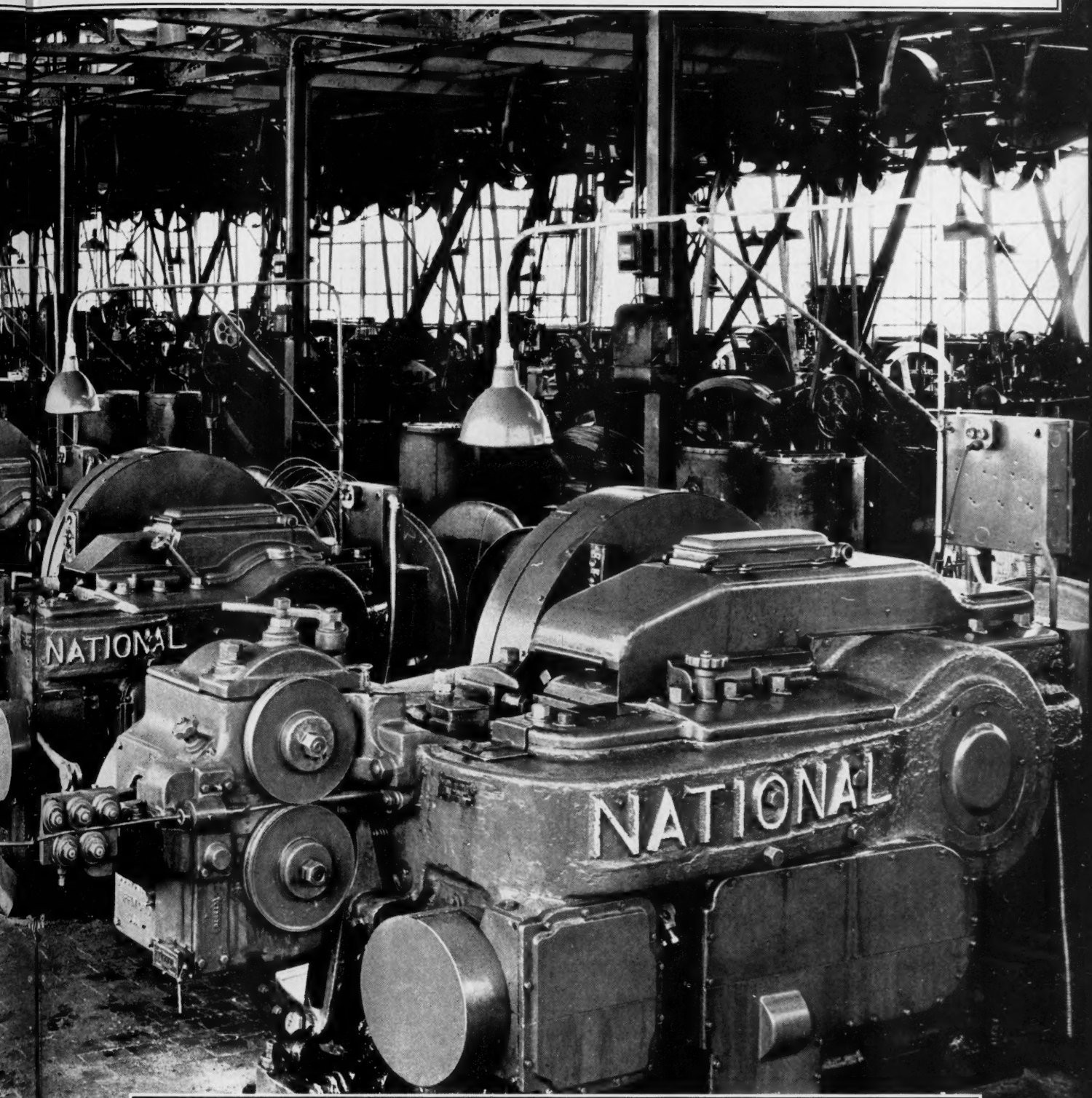

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the plastically deformed metal will take a permanent set. In view of the fact, that the true elastic limit is rather difficult to determine experimentally, we will confine our attentions to the yield strength. Yield strength may arbitrarily be defined as the maximum unit stress than can be developed in a material without causing more than a permissible set or deformation of 0.1 per cent of the gage length.

✦ ✦ ✦

THE stress strain curve in Figure 7, was taken on the .337″ wire after it had been drawn 19%. The yield strength 84,700# per sq. in. was determined by drawing line C D through point C, which represents 0.1% deflection, and parallel to the modulus line A B. The intersection with the stress strain curve at Y represents the yield strength. All the yield strength data in table 1, was determined by similar means.

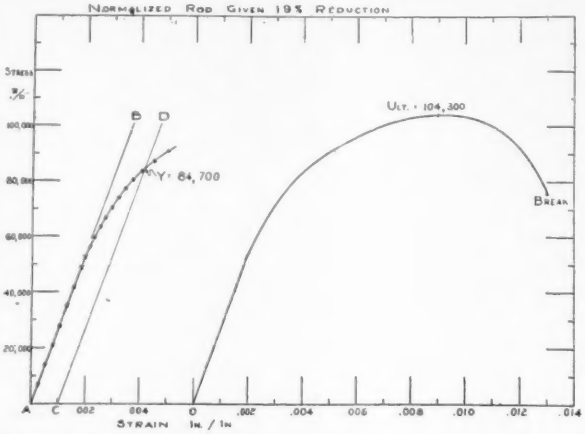


Figure 7. Stress—Strain curve on .337″ wire.

✦ ✦ ✦

THE wire suitable for cold heading showed a yield strength less than 90,000# per sq. in. It appears, that when the yield exceeds this amount, the extreme pressures encountered in the heading operation are so great that die failure occurs at an early date.

✦ ✦ ✦

SATISFACTORY cold heading wire must be extremely malleable. This may be compared with the ability of tensile specimens to neck-down when subjected to the breaking load. The reduction of area in the good wire exceeded 40%. Wire showing a reduction in area of 41.5% has recently been satisfactorily cold headed. A large amount of test data has been studied and in each case the results were found to be similar to those mentioned above. As a result, we may conclude that the reduction in area should exceed 40% in order that the material will flow properly in the die.

✦ ✦ ✦

Grain Growth

THERE has been considerable comment on grain growth brought about by subjecting cold worked material to elevated temperatures. Necessary precautions have to be taken in certain fields in order to avoid this detrimental effect. It is a significant factor under certain conditions, but it does not present as important a problem in the cold heading industry as casual observations would lead us to believe.

A VERY thorough study of the effect of strain on grain growth of low carbon steel wire was reported by **Mr. B. L. McCarthy (5).** His observations indicate that low carbon steel wire cold worked between 6 and 16% reduction is apt to develop grain growth on annealing. The critical strain point which produces maximum grain growth in annealing is in the neighborhood of 7%. The range in annealing temperature over which grain growth can occur may be from 1000 to 1600 degrees F., depending on the analysis of the steel and the degree of strain. The range of strain which produces grain growth is small at 1000 degrees F. reaches a maximum at 1350 degrees F. and falls off again as the temperature increases. An increase in the carbon content of the steel results in a narrowing down in the range in temperature which will produce grain growth, and also the range in per cent reduction over which grain growth occurs.

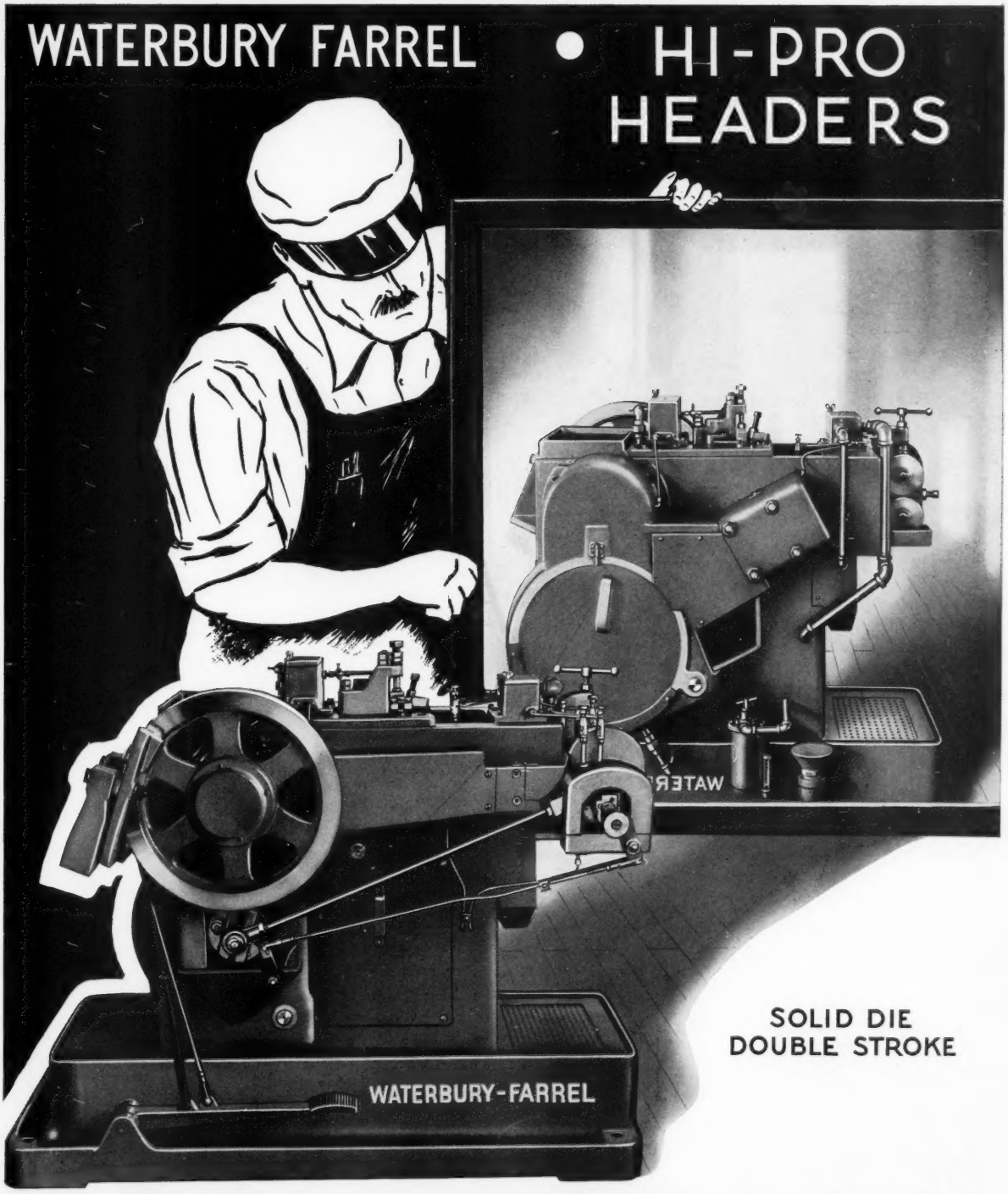
✦ ✦ ✦

BY drawing the material beyond the point of critical strain, the range in temperature which will produce grain growth is materially decreased. Subsequent cold heading operations also tend to overstrain the metal and the resulting headed blanks will show very little tendency toward grain growth, and in any event, the temperature range will be exceedingly small. By heating the material away from

TABLE 1
Physical Properties of Normalized Cold Drawn Wire

Diameter in Inches	Number of Drafts	Percent Reduction	Yield Strength Lbs. per Sq. In.	Tensile Strength Lbs. per Sq. In.	Elongation in 2-Inches	Reduction in Area	Heading Characteristics
.374″	Hot Rolled Rod		45,000	76,000	30.5	53.5	
.353″	½	11	78,240	94,240	15	51	Good
.347″	1	14	78,300	95,400	15	48.5	Good
.341″	1	16	73,800	100,000	11	47	Good
.337″	1	19	84,700	104,300	13	47.5	Good
.322″	1	26	93,000	105,500	7.5	38.0	Bad
.313″	2	30	95,500	106,400	8.5	33.8	Bad
.278″	3	45	114,000	125,100	6	29.4	Bad

WATERBURY FARREL • HI-PRO HEADERS



SOLID DIE
DOUBLE STROKE

For cold-heading rivet and screw blanks—These modern machines are designed to meet the present day demands for high speed, large quantity production, and economical operation—Two standard sizes: 3/16" by 1" at 225 per minute; 5/16" x 1½" at 175 per minute.

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the critical temperature, no difficulty should be encountered with grain growth. Material to be heat treated near the critical temperature should be cold worked either on the draw bench or in the headers to sufficiently over-strain the metal, so that, grain growth will not occur.

✦ ✦ ✦

LOW carbon wire can be cold headed after considerable reduction. As a result, it is very easy to completely elminiate the error of grain growth on subsequent heat treatments. Fortunately, the higher carbon material does not require the excessive cold work that low carbon steel requires, and as a result, it is also possible to control conditions to eliminate grain growth in cap screws, bolts, rivets, specials, etc.

✦ ✦ ✦

CLOSE co-operation between the wire mill, headers and heat treat departments can be so adjusted that very little fear of grain growth will be experienced. Bolt plants which are not equipped to do their own wire drawing, are at a slight disadvantage. They can overcome this by working in conjunction with the supplier to arrive at the proper wire temper to obtain the most advantageous balance in material. By this co-operation the fear of encountering detrimental grain growth can be held to a minimum.

✦ ✦ ✦

Work Hardening

THE permanent deformation of a metal at any temperature below its annealing temperature is cold working and the hardening produced is referred to as strain-hardening or work-hardening. Cold heading materially deforms the metal setting up severe strains. In many cases, the magnitude of the strain does not materially harden the metal and heat treatment is not necessary to remove strain brittleness. In many other instances, the working is so severe that the metal approaches the point of rupture.

✦ ✦ ✦

AN item familiar to us all which represents one of our more severely cold worked products is the standard carriage bolt. The head is thin and the ratio of head diameter to stock diameter is comparatively large. The blank head is extremely brittle and the bolt has no utility what-so-ever, unless, it is given a normalizing treatment sufficient to recrystallize the ferrite grains in the cold worked structure.

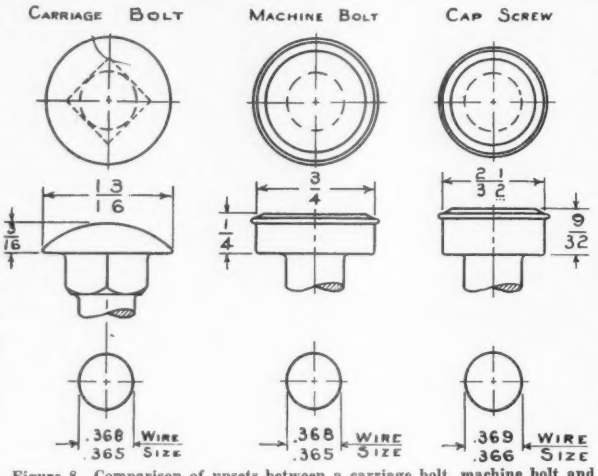


Figure 8. Comparison of upsets between a carriage bolt, machine bolt and cap screw.

✦ ✦ ✦

MACHINE bolts represent a medium degree of cold work. The heads are not excessively brittle and the bond between the head and shank is, in many cases, satisfactory. However, as a precautionary measure, the bolts are always subjected to a strain relieving heat treatment.

✦ ✦ ✦

CAP screws on the other hand, show only a moderate degree of strain hardening. The ratio of head diameter to stock diameter is comparatively small. As a result, there is very little tendency toward brittleness. This is particularly true of cap screws made by the single extrusion process from oversize stock and those made by the double extrusion process. As a matter of fact, there are a great many cap screws successfully used today which have not been given a stress relieval heat treatment. Figure 8, gives a relative comparison of the upset required to make a standard 3/8" carriage bolt, machine bolt and cap screw.

✦ ✦ ✦

HIGH quality cap screws of SAE 1035 and Alloy steel will continue for some time to be used in the heat treated condition. The uniformity and consistent degree of which their service performance characteristics can be predicted favor the heat treatment. The unheat treated high strength extruded cap screws may become more widely used after sufficient laboratory data is tied up with additional service applications. For the time being, however, standard practice is to use a material after being given a double heat treatment; that is, hardening and drawing or tempering to the desired specifications.

✦ ✦ ✦

Tensile Properties of Cap Screws

AT this time, let us confine our attentions to high quality SAE 1035 steel cap screws which have been given a hardening and tempering treatment. The bolt industry in general, is using chain belt, controlled atmosphere hardening furnaces and the latest types of recirculated air drawing furnaces. The method of determining hardenability properties of a heat of steel and then passing the entire heat through the mill in a body is gaining favor. This practice enables the hardening room to meet customers' specifications with a minimum of lost time.

✦ ✦ ✦

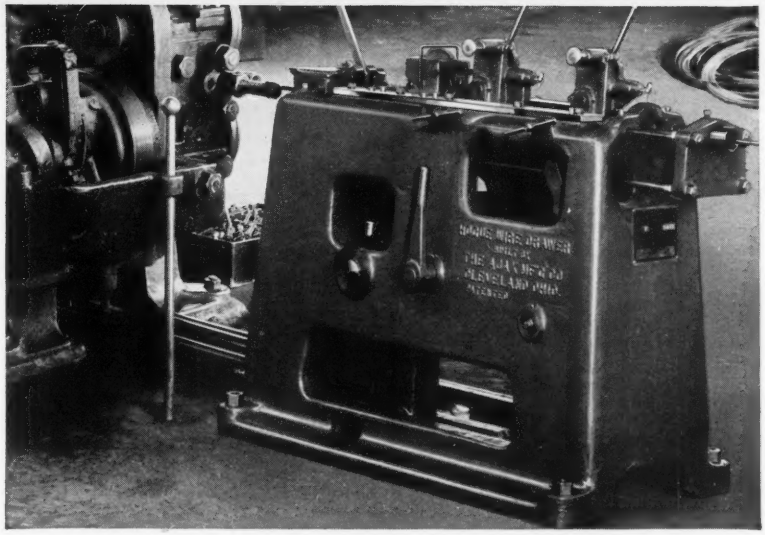
CUSTOMERS as a rule, specify Brinnell Hardness limits when ordering bolts. Some, however, also include breaking load requirements and others ultimate tensile strength. In order that we

(*Please turn to Page 595*)

AJAX

HOGUE WIRE DRAWERS

for Profits in Cold Heading



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Installation on any cold header is simple; the only connection to the header being a roller chain sprocket on the crankshaft. Hogue Wire Drawers are not operated from any light auxiliary mechanism of the header.

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INCREASED HEADER DIE LIFE

Substantially longer header die life, especially for close specification products, and increased operating efficiency result from straight, accurate, clean and freshly-drawn wire free from age hardening and gritty accumulation.

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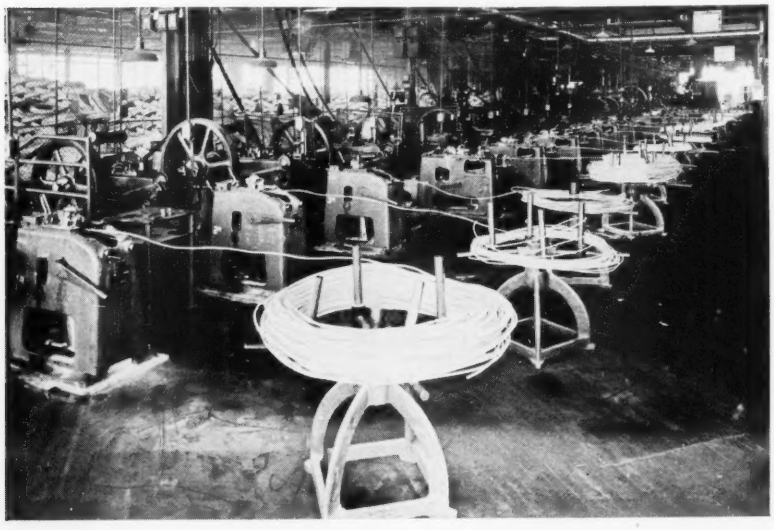
The savings in cost of hot rolled, pickled-and-limed rod as against cold-drawn wire, appreciably reduced pro-rated heading die costs and fewer production interruptions for header die changes greatly increase profits.

If you operate cold headers you should not fail to investigate the Ajax-Hogue Wire Drawer. Without obligation write for Ajax Bulletin No. 111.



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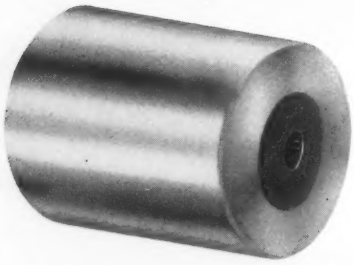
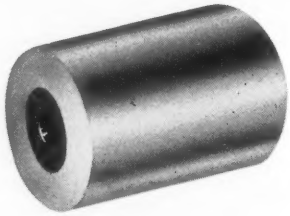


Firthaloy cold heading die, size .198" — produced 6,590,000 rivets on original size.

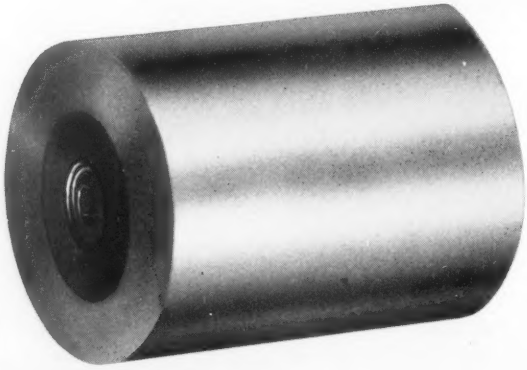


Firthaloy cold heading die, size .167" — produced 2,724,000 rivets then recut to .171" and produced 499,253 making a total production of 3,223,253 rivets.

FIRTH-STERLING FIRTHALOY QUALITY

Firthaloy cold heading die, size .248" — produced 295,000 Aircraft Bolts, SAE 2330 steel.

Firthaloy cold heading die size .191" — produced 4,164,800 flat head rivets.



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The Effect of Under Critical Annealing Treatments on Cold Drawn Carbon and Alloy Steels

By F. C. Brandon,
Metallurgist, Union Drawn Steel Div.,
Republic Steel Corp., Massillon, Ohio.

A study of methods designed to give still higher properties and greater hardness with the equipment available in the cold drawn bar industry and with costs comparable to or less than those of heat treating.

FOR several years cold working, principally cold drawing, has steadily gained recognition as a possible substitute for heat treatment as a means of obtaining desired physical properties within certain limitations. By heat treatment, in this case, we mean quenching from above the critical point and drawing back to the desired physical properties. Much of the work done in this connection has been along the trend of satisfying the specifications for various individual requirements and is allowed to more or less die in physical property files. Part of this is due to the fact that complete information in connection with test data of this type is non-existent due to the lack of time available for making a comprehensive study of the various physical properties to be expected from material utilized for each individual requirement. The above statements, in all fairness, are much more applicable to the bar industry than to wire where by the application of pretreatments, such as patenting, and the use of multiple passes, very high physical properties in small wire sizes have been obtained. This study, however, is limited to bar stock where multiple drawing is at present out of the question due to cost.

✦ ✦ ✦

IN connection with the above, several years ago we investigated to some extent the properties of several steels with varying degrees of cold work. This was done with the idea of arriving at a series of charts which would be of practical assistance in predicting the normal expectancy of physical properties for varying amounts of cold work. These charts are reproduced here as plates 1 to 4 inclusive.

✦ ✦ ✦

F. C. BRANDON

Born—New Castle, Penna., April 26, 1904. Graduated from Culver Military Academy, 1923; Lehigh University, Metallurgical Engineer, 1927. With National Tube Co., Lorain Works, 1927-1928; Union Drawn Steel Company, 1928. At present Field Metallurgist with Union Drawn Steel Division of Republic Steel Corporation, Massillon, Ohio. Member A. S. M.

S. A. E. 1112

PLATE #1, — S. A. E. 1112, indicates the inadvisability of using this grade for other than normal cold drawn requirements. The yield rapidly approaches the tensile and the ductility as indicated by the reduction of area and elongation is commencing to take a decided dip. It is unfortunate that impact tests were not included in this program. However, experience has proven that this grade shows a decided loss in ductility, as measured by Izod, with increasing cold work.

✦ ✦ ✦

S. A. E. X-1020

PLATE #2, S. A. E. 1020, was of particular interest for shafting application. Shafting is a popular commercial application of this grade and heavier than normal drafts (10/12%) resulted in an appreciable increase in both ultimate strength and yield. This was correspondingly reflected in increased torsional strength, which was a highly desirable condition.

✦ ✦ ✦

S. A. E. 3135

PLATE #3, represents material cold drawn from hot rolled and annealed S. A. E. 3135. The annealed structure was approximately 70% pearlitic and 30% spheroidized. These curves are similar in contour to those of plate #2. This

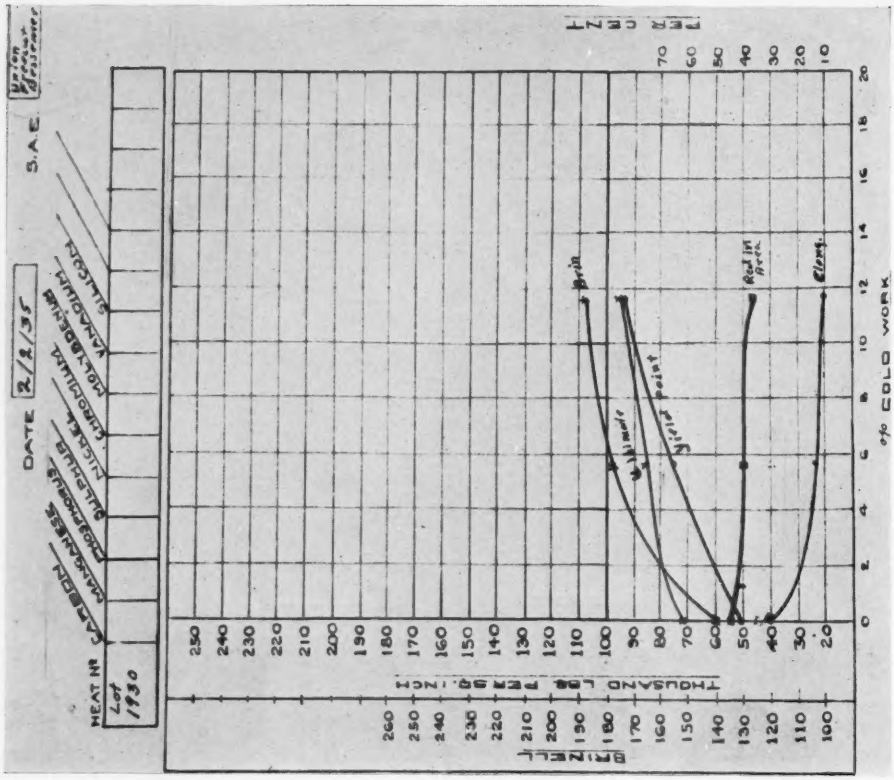


Figure 1. S. A. E. 112.

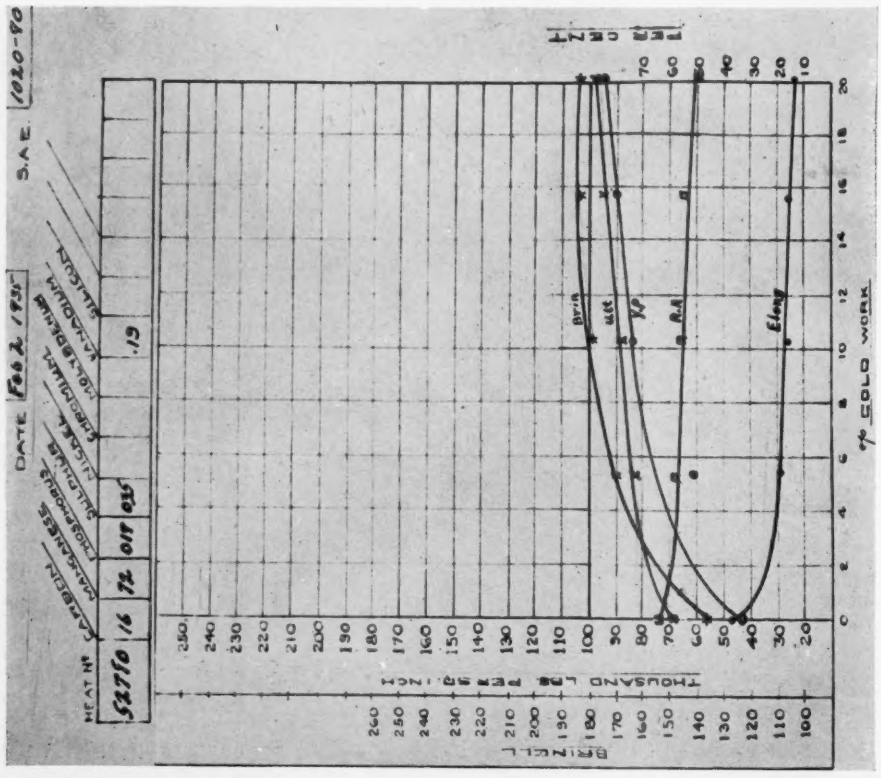


Figure 2. S. A. E. 1020.

was investigated, primarily for comparison with results shown in plate #4. It has been found advantageous to start with hot rolled rather than hot rolled annealed when attempting to develop higher than normal cold drawn physicals.

✦ ✦ ✦

Cold Drawn Unannealed Hot Rolled Material

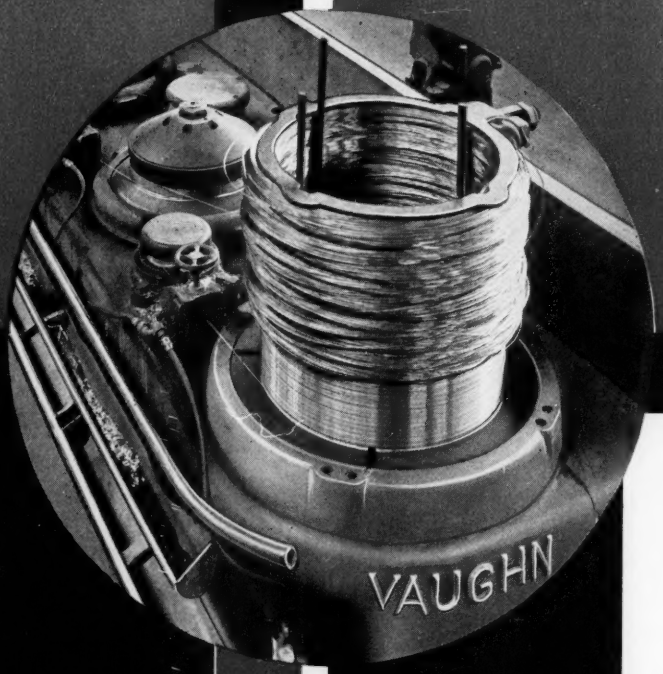
PLATE #4, therefore, represents material cold drawn from unannealed hot rolled and shows an entirely different type of curve. The increase in ultimate, yield point and brinell are, as far as the curve progresses, straight line functions, as are the decreases in ductility. It is further significant that the maximum hardness is in the neighborhood of 260 brinell. We have reason to believe from past experience that the brinell curve, with increasing percentage of cold work, would have been inclined to level off, as 269 brinell represents the normal maximum hardness to be obtained by cold drawing alone.

✦ ✦ ✦

THIS preliminary work led to the present study which is the result of an effort to gain still higher properties and greater hardness with the equipment available in the bar industry

VAUGHN

WIRE DRAWING MACHINERY



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Above: VAUGHN HR series MOTOBLOX
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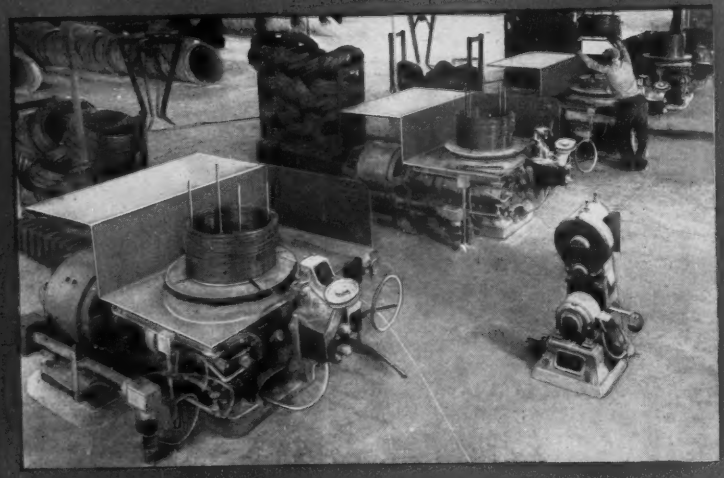

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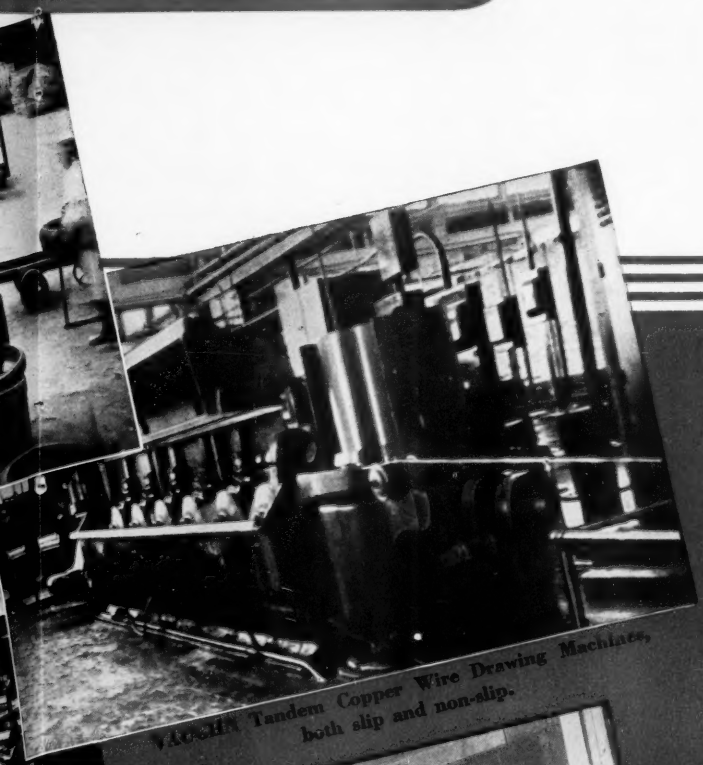

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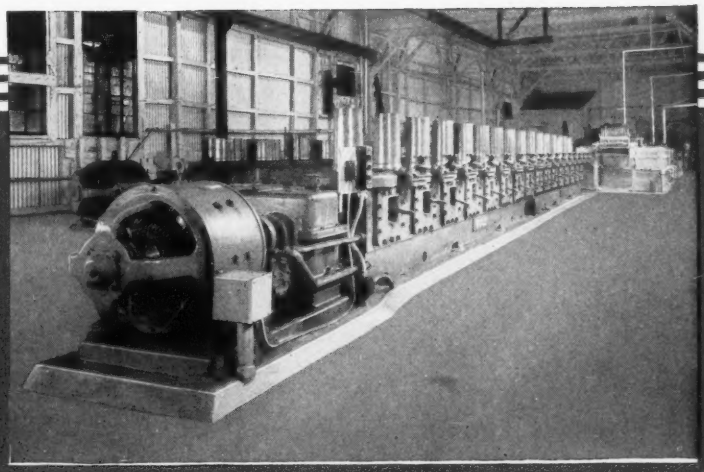

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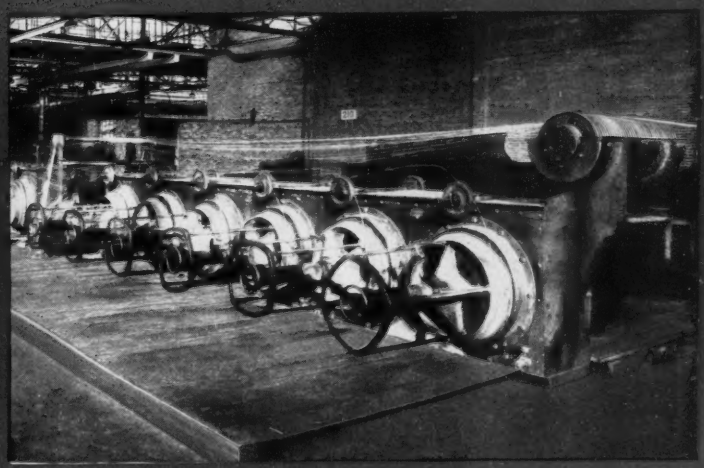

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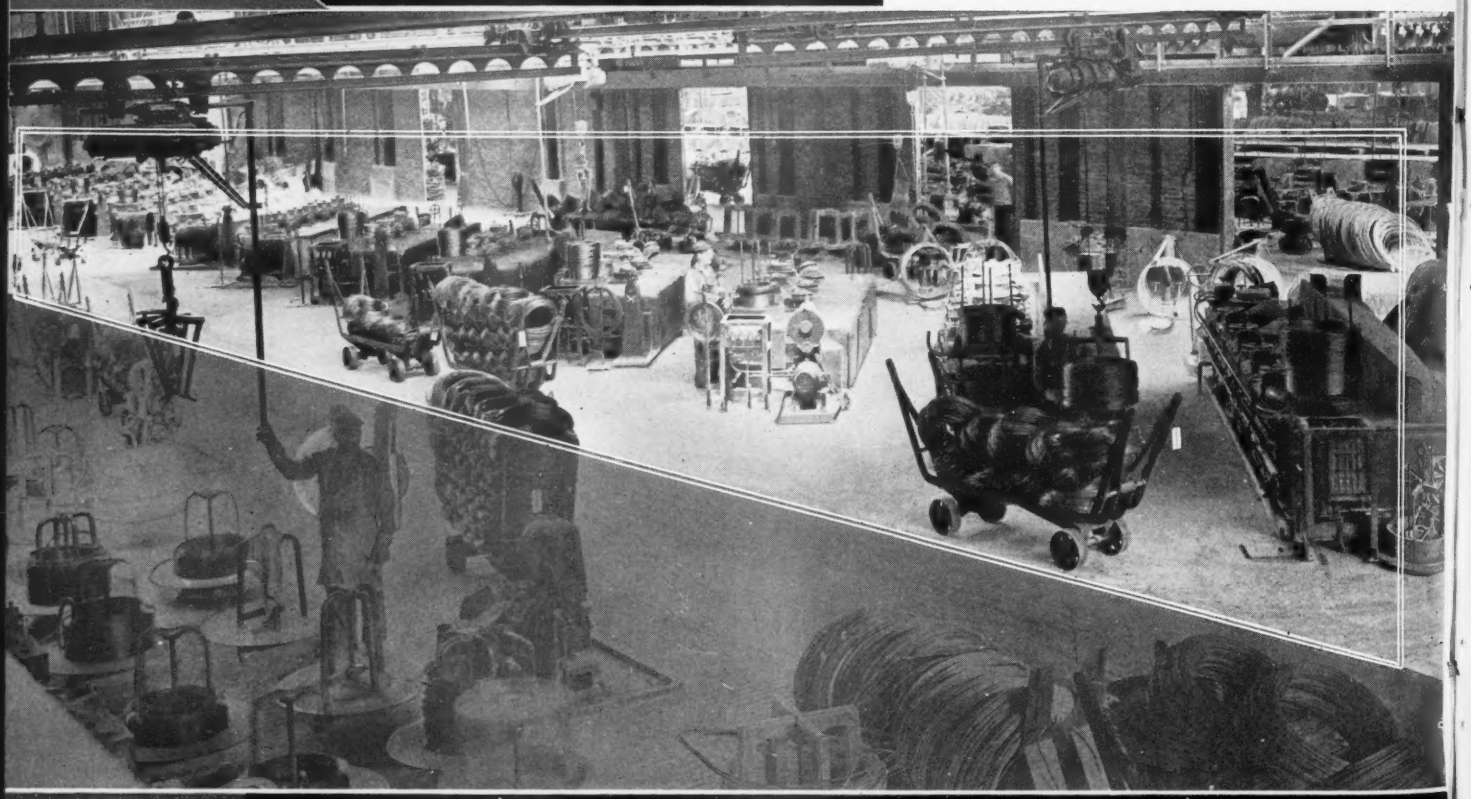

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FERROUS NON-FERROUS MATERIALS OR THEIR ALLOYS

and with costs comparable to or less than those of heat treating.

✦ ✦ ✦

THIS effort was directed along the lines of low temperature anneals conducted after cold drawing or what is commonly termed as "strain annealing." Strain annealing is in effect accelerated aging. It is not within the scope of this study nor the intention of the author to investigate the cause of aging or to advance any theories in this connection, but a brief reference to it may be in order. Aging in iron and steel is defined by Epstein and Miller as the spontaneous change in properties at room temperature with time, the process being accelerated by raising the temperature. Further, aging is divided into two distinct classes, quench aging and strain aging. Strain aging is the type in which we are now interested.

✦ ✦ ✦

Grades Selected for Test

FOUR grades were selected for the test on the basis of experience with their adaptability for this type of treatment. The detailed analyses are listed in table #1. With the exception of steels 31 A and 31 B (S. A. E. 3135) which were handled as a separate investigation, the test pieces for each grade were obtained

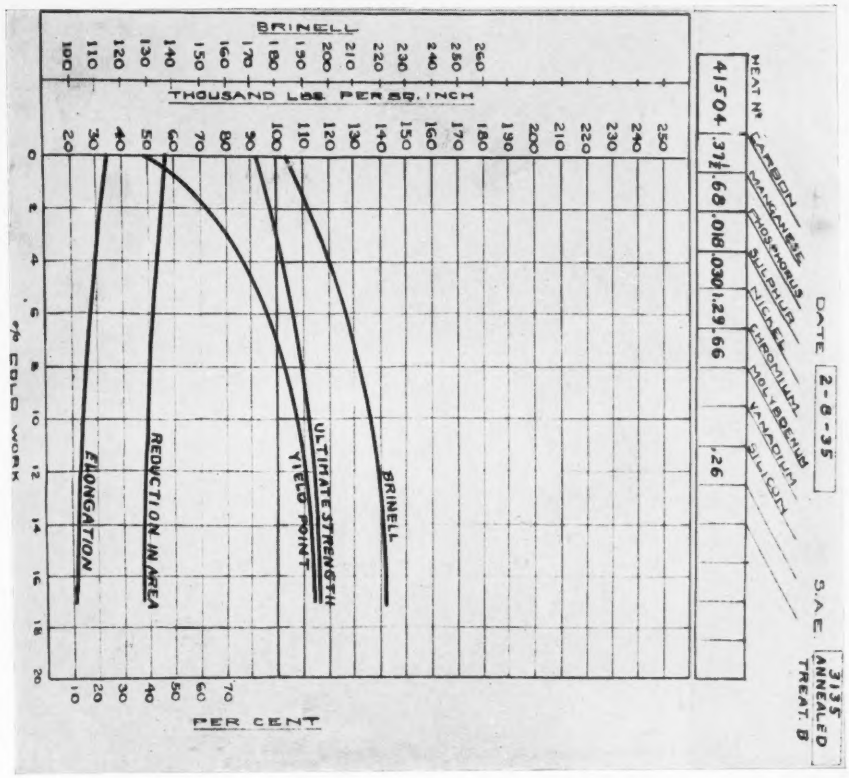

Figure 3. S. A. E. 3135.

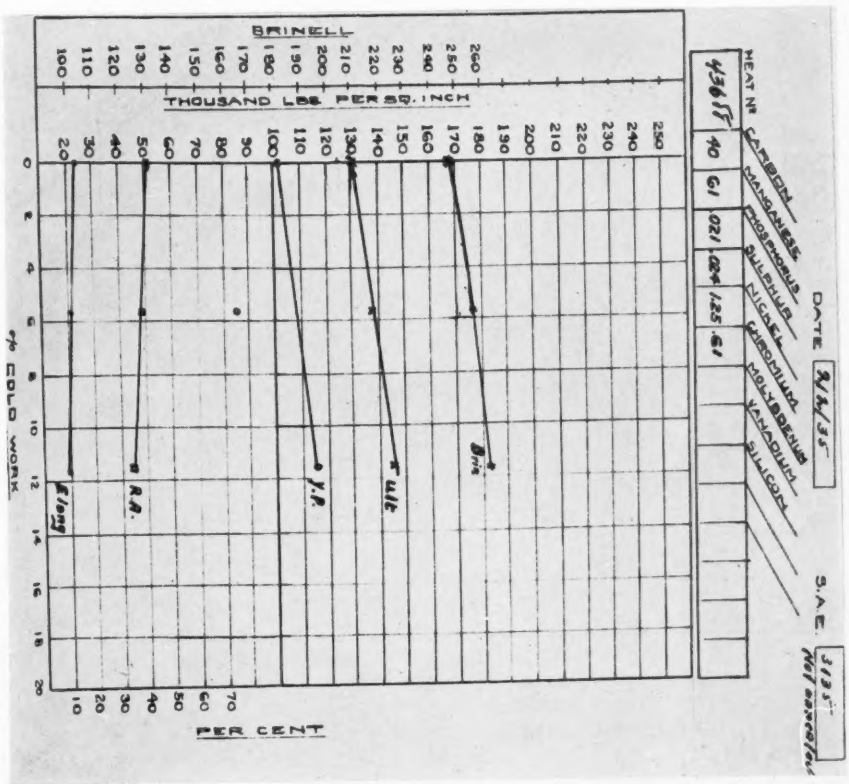

Figure 4. Material cold drawn from unannealed hot rolled.

COMPLETE WIRE DRAWING EQUIPMENT . . . CONTINUOUS OR SINGLE HOLE . . . FOR THE LARGEST
FERROUS NON-FERROUS MATERIALS OR THEIR ALLOYS

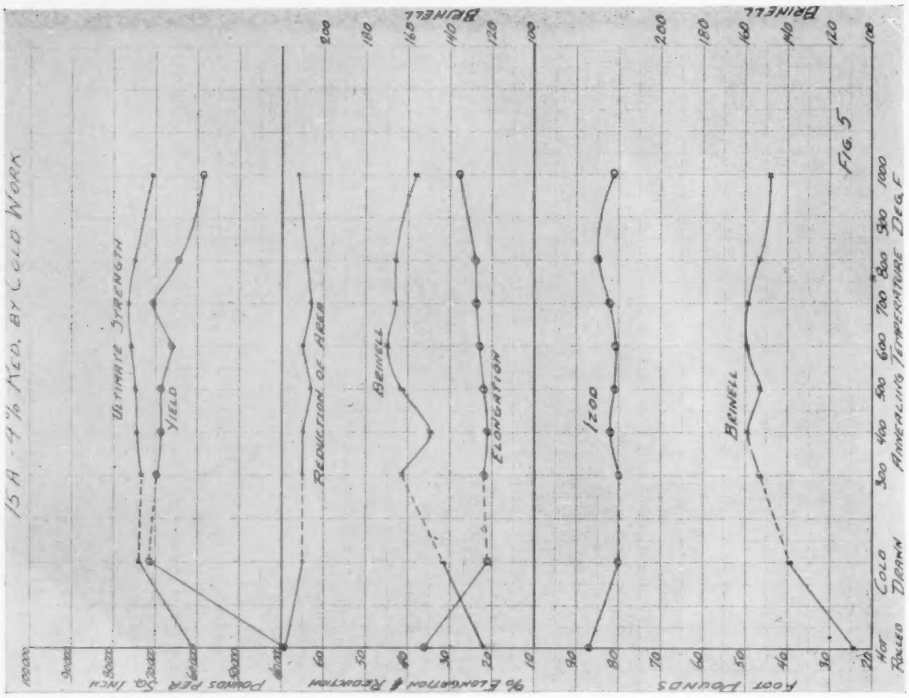

Figure 5.

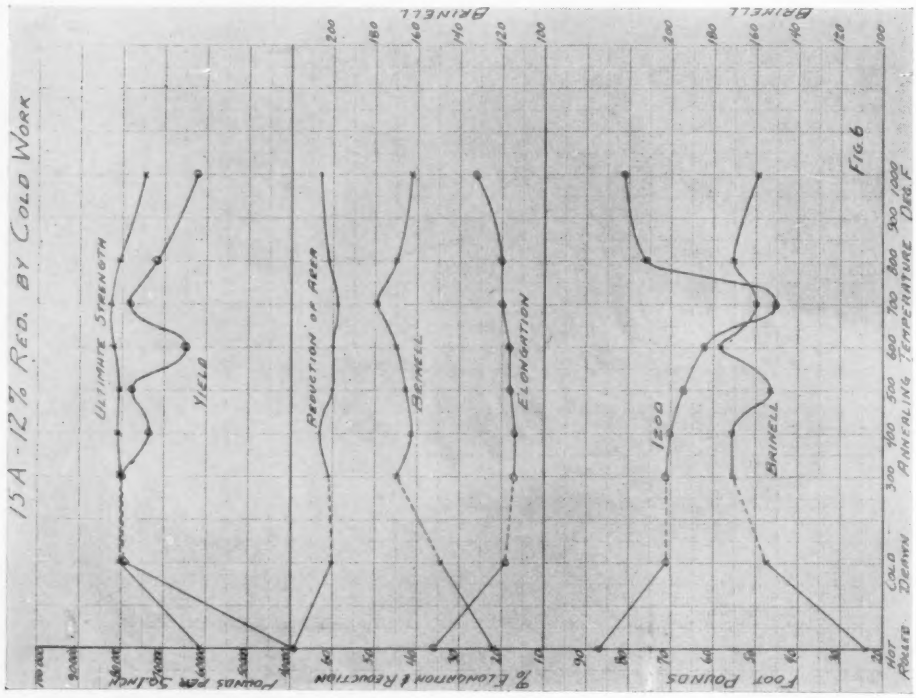

Figure 6.

TABLE I

NO	C	MN	P	S	SI	NI	CR	EH N
15A	17	66	015	037	14	12	03	7
45D	50	72	012	037	20	14	06	7/6
13B	41	1.42	020	115	17	08	09	6/7
31A	35	68	018	022	23	1.25	68	7
31B	41	74	024	029	18	1.29	65	7/6

from single bars. This served to eliminate, as far as possible, variations in chemistry and rolling conditions. Each bar had the initial hot rolled sample removed and was then cut into three lengths. The material was pickled in dilute sulphuric acid, limed and cold drawn with the pre-determined amount of draft. A period of probably 24 hours elapsed between pickling and drawing. As soon as possible after drawing, each bar was cracker cut into 14" lengths. Straightening had been eliminated as an unnecessary operation, and one of no importance to the physical properties due to variation normally expected from roll pressures and speeds.

✦ ✦ ✦

Testing Furnace Used And Method Followed

ALL annealing treatments were conducted in a Homo draw furnace with automatic temperature control to plus or minus 10°F. The time at temperature for all annealing treatments was one hour, measured from the time the furnace charge had attained the desired temperature. Test pieces after removal were cooled in still air although no definite precautions were taken in cooling.

IN view of data obtained, we wish to stress the point that each temperature group, that is, all tests annealed at the same temperature, with the exception of 31 A and 31 B (S. A. E. 3135), was annealed in the same furnace charge and, therefore, had exactly the same cycle.

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AFTER annealing, each 14″ piece was cut into two pieces 8″ and 6″ long for tensile and impact tests respectively. The tensile tests used were the standard .505″ round turned on center. The

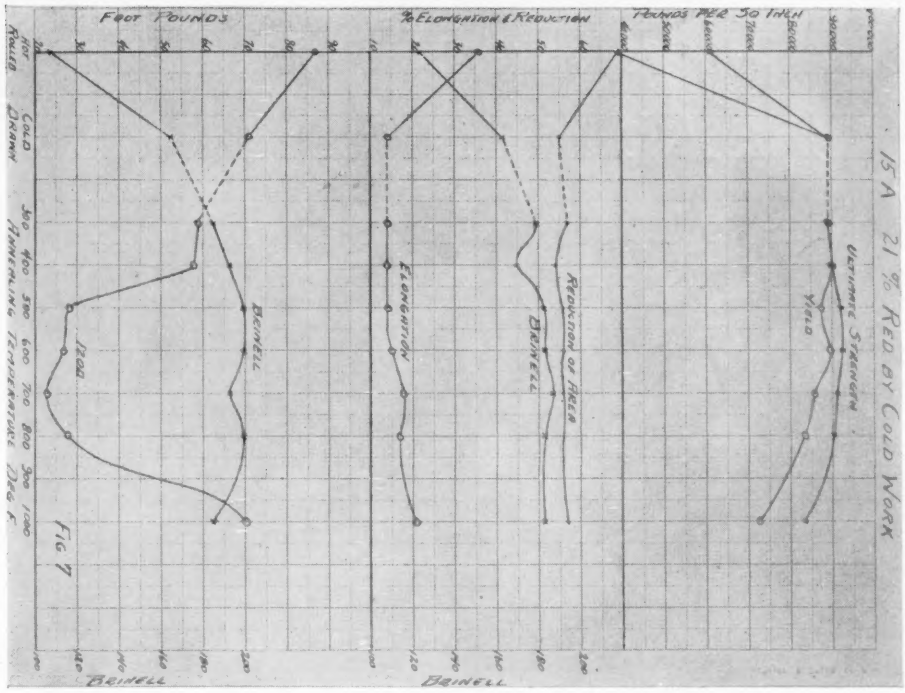

Figure 7.

TABLE II
Physical Properties of Steel 15A

DRAW	ULTIMATE	YIELD	ELONGATION IN 2″	REDUCTION OF AREA	BRINELL	IZOD	IMPACT BRINELL
			4% Cold Work				
HR	61100	39250	36	69	124	87	108
CD	74000	71400	21	65	143	89	139
300	73400	69900	22	65	163	80	153
400	74650	68400	21	65	149	82	159
500	74400	68900	22	63	163	81	153
600	75700	66050	23	65	170	81	159
700	76300	70800	24	63	166	82	159
800	74850	64550	24	64	166	85	153
1000	70350	58450	28	68	156	81	148
			12% Cold Work				
CD	80200	79400	19	60	149	71	155
300	80100	80100	17	61	170	71	171
400	80900	73450	17	63	163	70	171
500	80950	77600	18	60	166	67	153
600	81850	64550	18	60	170	62	177
700	82850	78050	20	59	179	45	159
800	80750	72000	20	61	170	76	171
1000	74650	62250	26	63	163	81	159
			21% Cold Work				
CD	89350	89350	14	55	163	71	165
300	89200	89200	14	57	179	59	185
400	90150	90150	14	54	170	58	193
500	92200	87500	14	56	183	28	200
600	92500	89900	15	56	183	27	200
700	91050	85750	18	56	187	23	193
800	90450	83550	17	56	183	28	200
1000	83750	72500	21	57	183	70	185

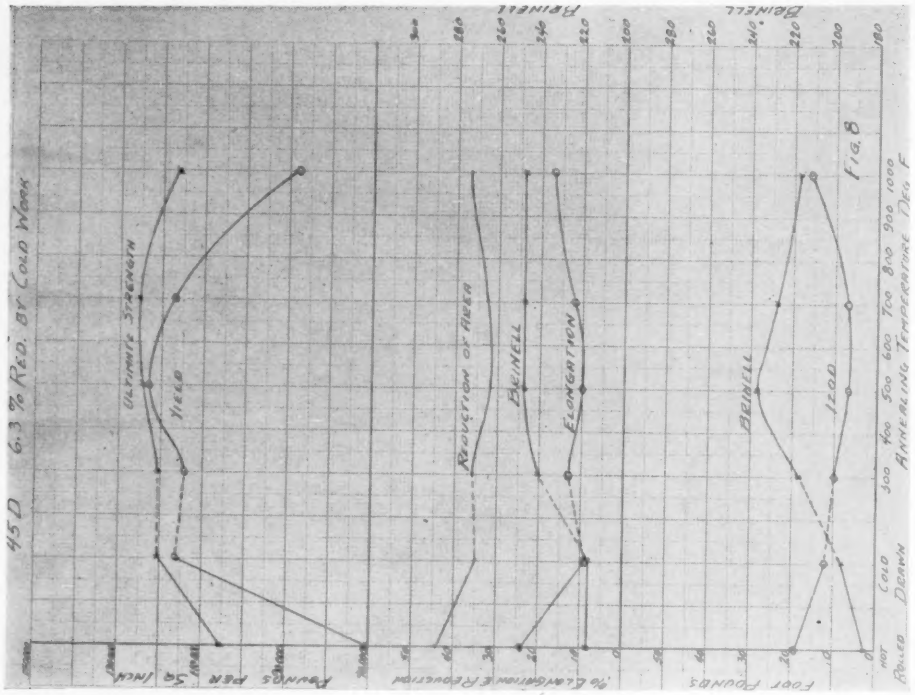

Figure 8.

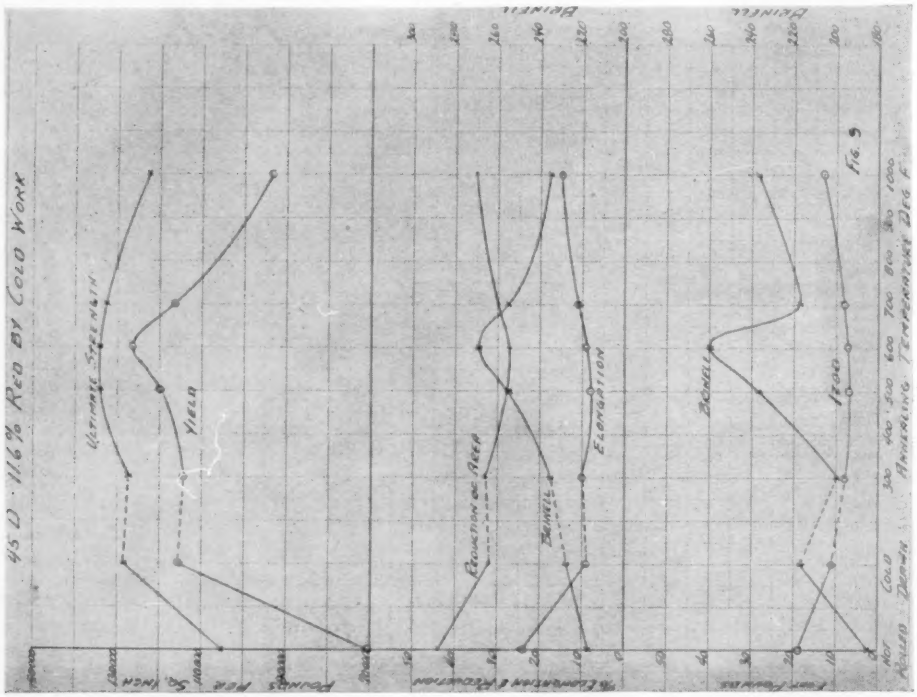

Figure 9.

impacts were the standard .394" square Izod tests planed and ground at half radius and notched on four sides. Tensile tests were completed within 24 hours of the annealing treatments, but due to the great amount of machine work involved in milling impact tests, a time interval up to two weeks elapsed before these tests were completed. This information is pertinent in view of later results. The yield point was taken with dividers and was accompanied by a decided drop of beam for all but the cold drawn unannealed tests. This would be in accord with the return of the jogged stress-strain curve reported by a great number of investigators, when studying aging effects after straining.

✦ ✦ ✦

Results of Tests

THE results of these tests are given in tables II to IV inclusive. Table V shows results obtained from 3135 steel. These results are shown graphically in figures 5 to 15 inclusive.

✦ ✦ ✦

IN studying these curves, it is well to take the group of curves for each grade as a unit. Each of these curves represents a certain amount of cold work.

✦ ✦ ✦

FIGURES 5, 6 and 7 are results obtained on steel 15 A (S. A. E. 1015) with 4%, 12% and 21% reduction by cold work respectively, showing the effect of annealing at various temperatures on the physical properties. Figure 16 is the structure of this grade in the hot rolled condition. This material was not annealed prior to cold drawing. It will be noted that with successively heavy drafts the ultimate strength, yield point and brinell all attain higher figures as cold drawn. It is also of interest that in the case of this steel, subsequent anneals are beneficial to the brinell only. With subsequent annealing the tensile

remains practically constant with softening indicated in the neighborhood of 900° F. The yield point becomes less with temperature increases. It is interesting to note the increase in brinell hardness from that as cold drawn to the results shown for the 300° anneal. The ductility as shown by elongation and reduction of area does not appear to have been greatly affected by annealing. The Izod is decidedly affected in the heavier drafts which may be explained by the theory that precipitation can not occur rapidly enough at the lower temperature in a dynamic test of this nature to be definitely determined. Obviously, with the exception of the desire for higher brinell, this particular heat, and in all probability this grade, is not benefited by low temperature annealing designed to increase strength.

✦ ✦ ✦

FIGURES 7, 8 and 9 represent the series of tests conducted on steel 45 D (S. A. E. 1045) cold drawn from unannealed hot rolled. The structure of this material in the hot rolled state is shown in figure 17. It is indeed unfortunate

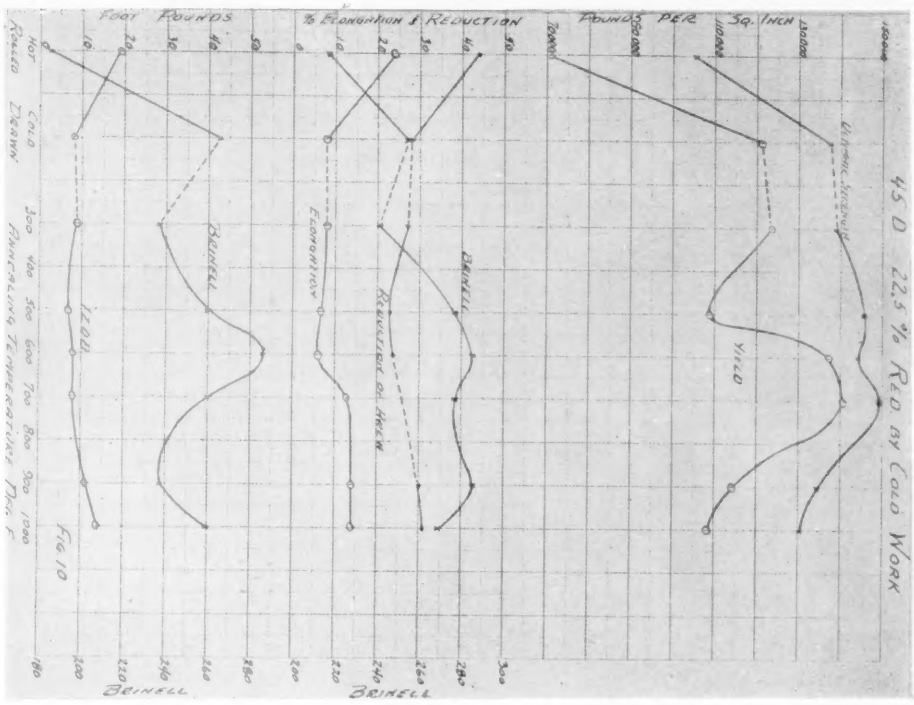

Figure 10.

TABLE III
Physical Properties of Steel 45D

DRAW	ULTIMATE	YIELD	ELONGATION IN 2"	REDUCTION OF AREA	BRINELL	IZOD	IMPACT BRINELL
			6.3% Cold Work				
HR	105375	70750	24	44	217	19	185
CD	120400	116225	9	35	217	12	196
300	120900	114250	13	36	241	10	217
500	124300	123050	10	32	248	7	237
700	125950	116950	12	33	248	7	228
1000	116750	87550	17	37	248	16	217
			11.6% Cold Work				
CD	128550	115600	9	32	228	11	217
300	127500	114100	10	33	235	8	200
500	134150	119800	8	28	255	7	237
600	134250	126550	9	27	269	7	260
700	132900	116650	11	30	255	8	217
1000	122950	93600	15	35	235	13	237
			22.5% Cold Work				
CD	137750	121150	8	28	255	8	266
300	139250	123850	8	27	241	9	237
500	145950	108850	7	23	277	7	260
600	144250	137250	6	24	286	8	286
700	149700	140650	13	45	277	8	260
900	134850	114200	14	30	286	11	237
1000	130500	108250	14	31	269	14	260

that sufficient material was not available from the one bar to give us test data for all annealing points. The lack of data for temperature points 400° and 600° is particularly unfortunate in view of the interesting results obtained at these temperatures with other grades. Decided increases in strength and hardness are evident as a result of annealing this grade after cold drawing. There is evidence of ductility loss, to be sure, but this loss is not out of proportion with the gain in strength and does not represent a severe condition. It is interesting that the brinell on impact specimens more closely follows the brinell on tensile specimens for this material than in either steels 15 A (S. A. E. 1015) or 13 B (X-1335). There was an interval of probably two weeks between the two brinell series, the impact series being taken at the later date.

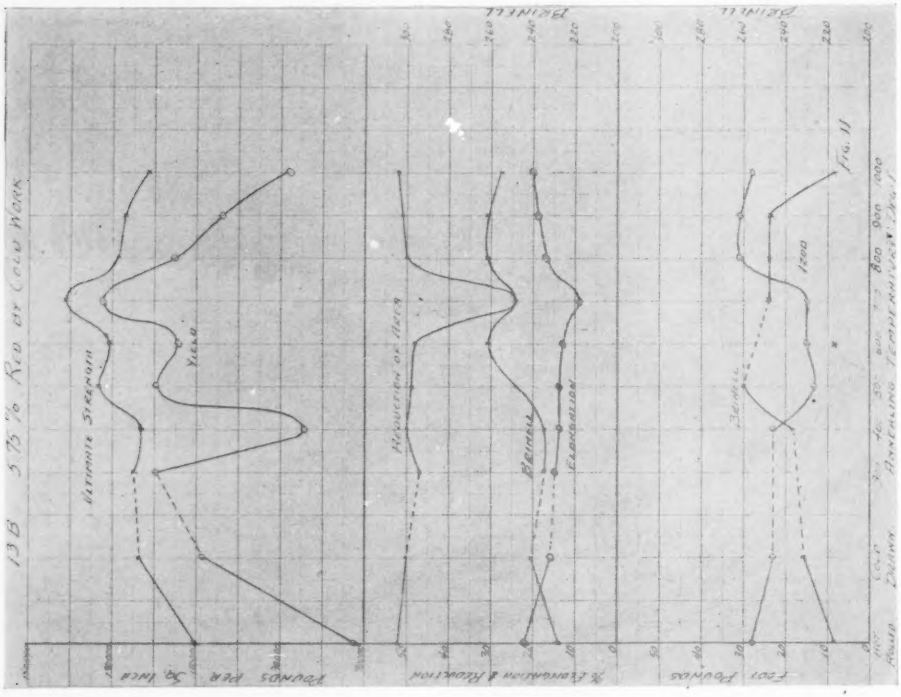

Figure 11.

✦ ✦ ✦

FIGURES 11, 12 and 13 represent the series of tests conducted on steel 13 B, (X-1335), cold drawn from unannealed hot rolled stock. The hot rolled structure is shown in figure 18. This series is by far the most interesting from the standpoint of physical properties. It will be noted that as the temperature increases a series of jogs are evident in tensile, yield and brinell. In fact, the yield at 400° goes lower in proportion as the amount of cold work increases. This might well indicate a decided recrystallization at this temperature. Good results are obtained with this grade as far as an increase of physical properties are concerned. The ductility as measured by impact, reduction of area and elongation is not too seriously affected in proportion with the strength and hardness obtained. It is to

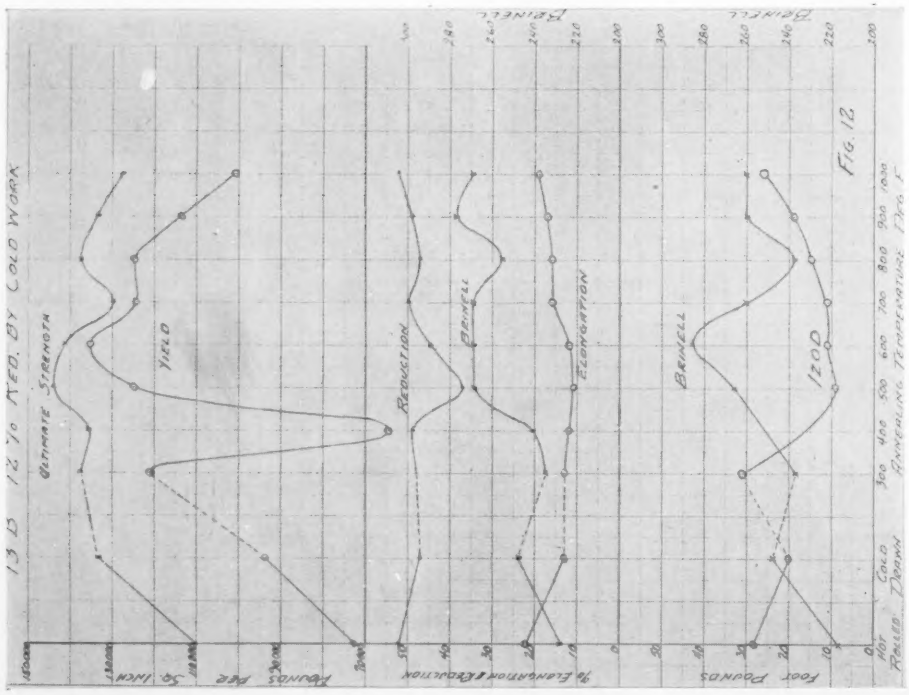

Figure 12.

be noted that the Izod brinell follows the tensile brinell rather closely, although the Izod brinell is a smoother curve than the tensile brinell.

✦ ✦ ✦

FIGURES 14 and 15 show results on 31 A and 31 B (S. A. E. 3135). In these two cases the hot rolled material was annealed to 100% spheroidization prior to cold drawing. This, no doubt, resulted in more even curves. The effect on ductility as shown by Izod, elongation and reduction is decidedly bad. In fact, the Izod

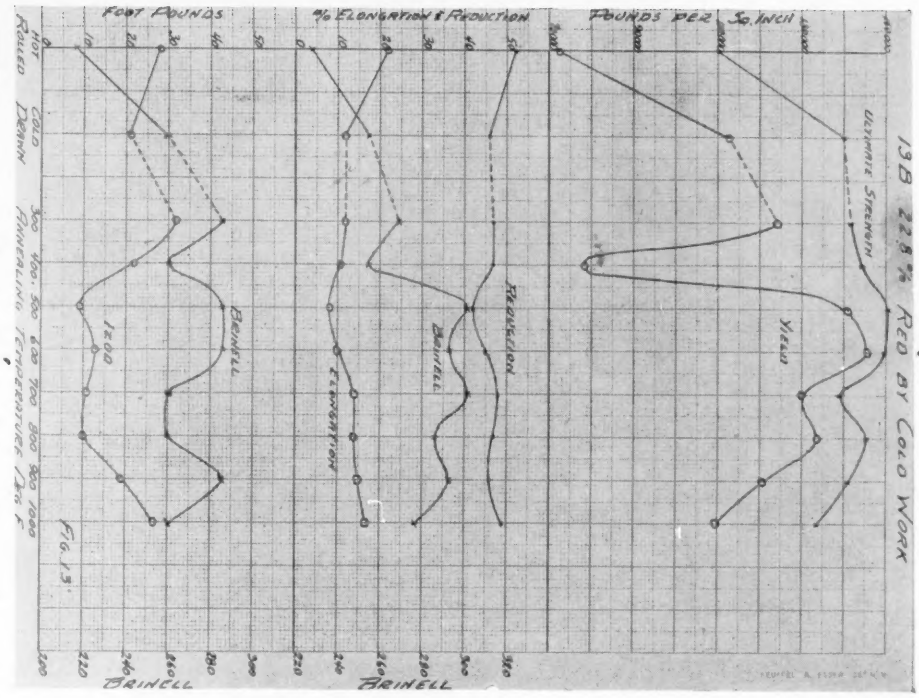

Figure 13.

TABLE IV
Physical Properties of Steel 13B

DRAW	ULTIMATE	YIELD	ELONGATION IN 2"	REDUCTION OF AREA	BRINELL	IZOD	IMPACT BRINELL
			5.75% Cold Work				
HR	110250	72450	22	52	228	28	217
CD	123600	108500	16	50	241	23	232
300	125000	119950	15	47	235		
400	123050	84250	14	50	235	23	237
500	133450	119800	14	49	248	13	260
600	130800	114200	13	48	262	15	217
700	141400	132300	9	24	248	15	248
800	128950	115200	17	50	262	31	248
900	127050	104100	19	51	262	31	248
1000	121450	88000	20	52	255	28	217
			12% Cold Work				
CD	133400	93750	13	47	248	20	248
300	137750	121150	13	48	235	31	237
400	135650	64450	12	49	241		
500	144100	125000	11	37	269	9	266
600	141550	135300	12	45	269	11	286
700	129950	124150	16	50	269	11	260
800	137400	124450	16	47	255	15	237
900	133200	113450	17	49	277	19	260
1000	127250	100990	19	52	269	26	269
			22.8% Cold Work				
CD	140150	112550	12	46	255	21	260
300	141800	124350	12	47	269	32	286
400	144250	78350	11	47	255	22	260
500	151250	141050	8	42	302	9	286
600	149900	145400	10	45	293	13	286
700	139050	130000	14	48	302	11	260
800	145500	133450	14	47	286	10	260
900	141000	120900	15	46	293	19	286
1000	133800	109450	17	49	277	27	260

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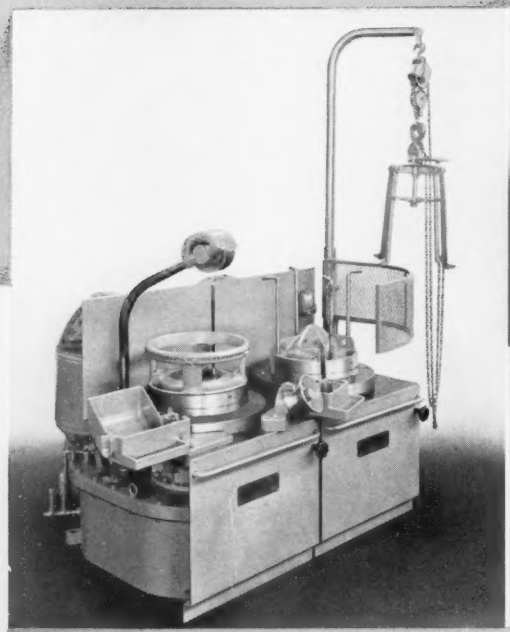

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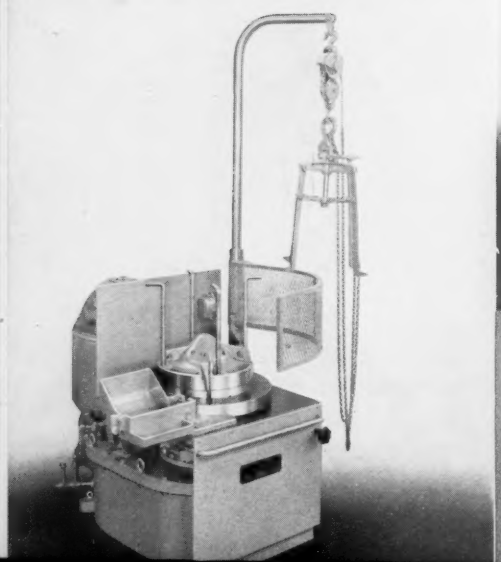

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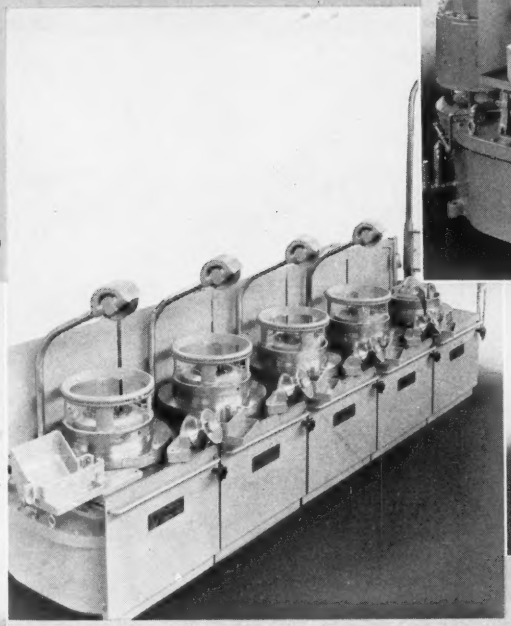

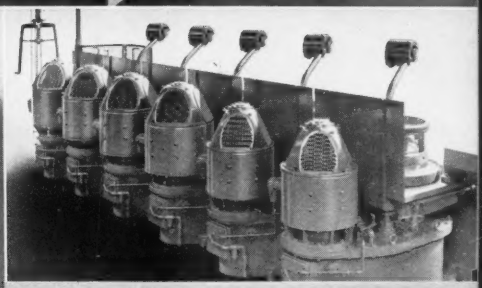

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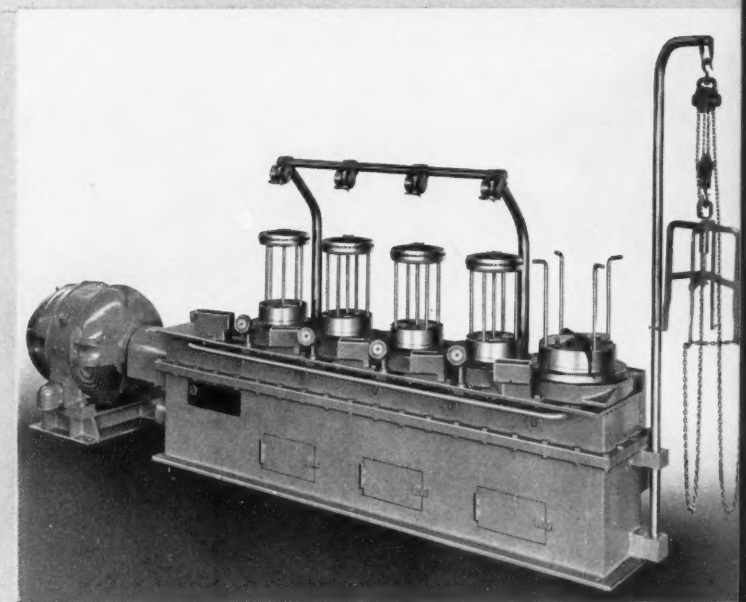

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shows worse in proportion to strength in this particular case than in the case of steel 13 B, (X-1335) which had really high physical properties.

✦ ✦ ✦

Conclusion

TEST data and curves on physical properties of various steels with varying amounts of cold work are shown. These are included as they indicate a maximum strength dependant upon the capacity for cold work of the particular grade and heat involved.

✦ ✦ ✦

IT has been shown that in general a decided increase in both tensile and yield can be reasonably expected by the use of annealing treatments in the neighborhood of 500 to 800°F applied after cold drawing. This increase appears to be more pronounced in steels having carbon content in excess of .17 as at .17 carbon we obtained a loss in yield through the use of anneals as compared to the properties of cold drawn steels untreated. In the two cases where the data was available, we found a loss of yield at 400°F. with a recovery at 500°. This loss in yield was reflected, surprisingly, in the brinell with very little apparent effect on the tensile strength or ductility. This condition may be explained as a recrystallization period.

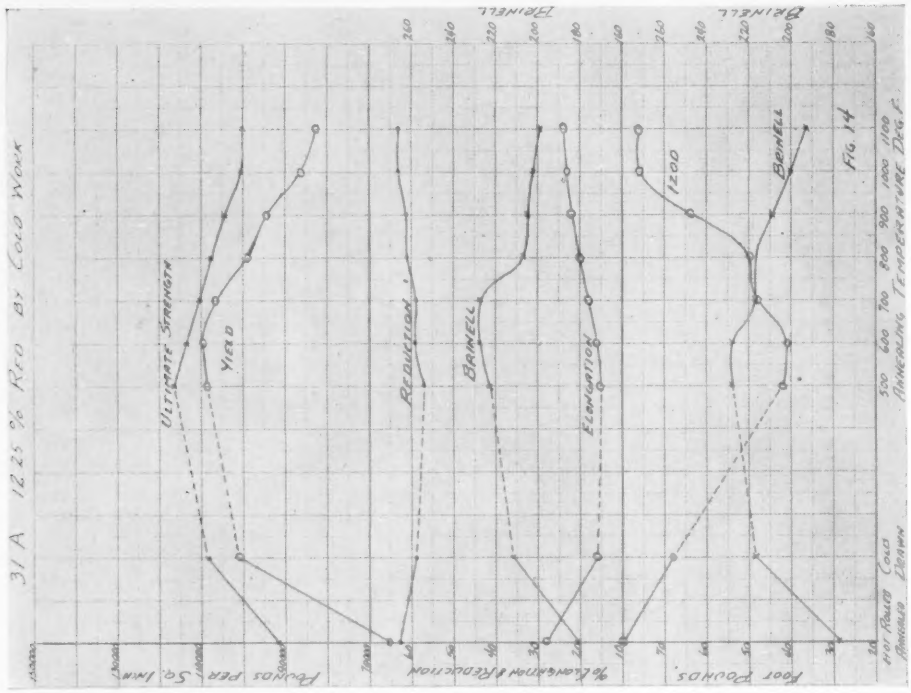

Figure 14.

✦ ✦ ✦

IT has also been shown that the reflection on impact was not particularly bad except in connection with the tests which had been annealed prior to cold drawing and which had an extremely high impact as annealed. Even in these cases, cold drawing with heavy drafts brought the impact down to such a figure that the additional loss in impact by subsequent annealing was relatively small.

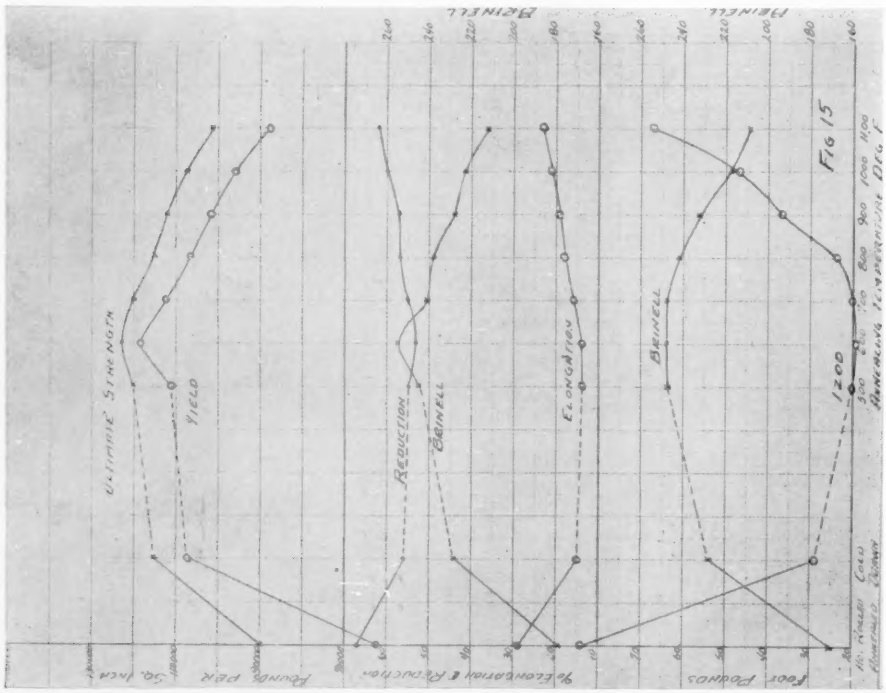

Figure 15.

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IN view of the fact that tensile brinells were made very shortly after annealing and impact brinells quite some time later, it is significant that these two are not always in accord which causes suspicion of additional aging. All of these tests were conducted on fine grained steels and it is reasonable

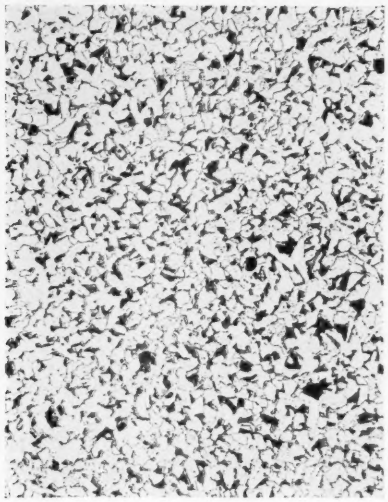

Figure 16. S. A. E. 1015.

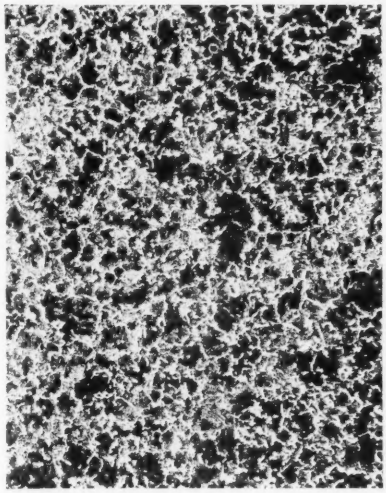

Figure 17. S. A. E. 1045.

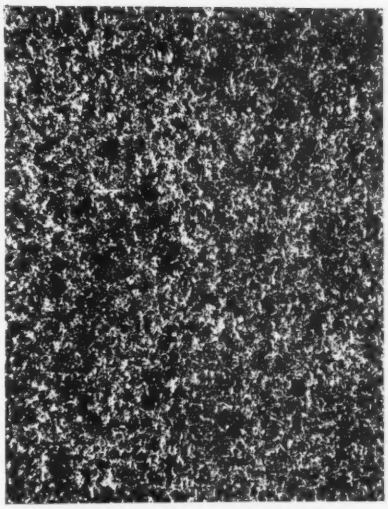

Figure 18. S. A. E. X1335.

to expect a more decided loss in ductility and also higher strength with coarse grained steel. From the standpoint of machinability which is constantly of primary importance to the bar industry, it is reasonable to expect better machining characteristics from material cold drawn and annealed to certain physicals than from the same material heat treated to the same physicals. This has been proven in practice where this method of treatment has superceded heat treating. This decidedly agrees with Armour's theory of machinability, namely, that slip planes developed in ferrite have the same effect of increasing machinability as the plates of iron carbide in pearlite. This structure would naturally machine much more readily than the fine grained martensitic structure resulting from heat treatment, strength and hardness being equal.

✦ ✦ ✦

THERE is no doubt that the physical properties will vary from heat to heat, or that they are affected by the method of manufacture,—principally the method of deoxidation. The inherent or McQuaid-ehn grain size and the micro structure of the original material will also have pronounced effect on the properties. We believe, however, that this method represents a practical manner of obtaining desired physical properties within certain limitations and of particular importance where it is necessary to finish machine after hardening.

TABLE V
Physical Properties of Steel 31A

DRAWN	ULTIMATE	YIELD	ELONGATION IN 2"	REDUCTION OF AREA	BRINELL	IZOD	IMPACT BRINELL
			12.25% Cold Work				
ANN	91775	65150	28	63	181	80	177
CD	108350	101250	16	59	212	68	217
500	116700	108300	15	57	223	42	228
600	113500	109800	16	59	228	41	228
700	110250	106700	18	59	228	48	217
800	107900	98800	20	61	207	50	217
900	104800	94250	22	61	205	64	209
1000	100450	86250	23	63	202	76	200
1100	100250	82600	24	63	199	76	193
			Physical Properties of Steel 31B				
			21.3%				
ANN	90000	62250	29	67	179	84	171
CD	115300	107650	15	56	228	29	228
500	120200	111700	14	55	245	20	248
600	123200	118500	14	53	255	19	248
700	120100	112400	16	55	241	20	248
800	116000	106800	18	57	238	24	242
900	112200	101500	19	57	228	37	233
1000	107500	96000	21	60	223	47	217
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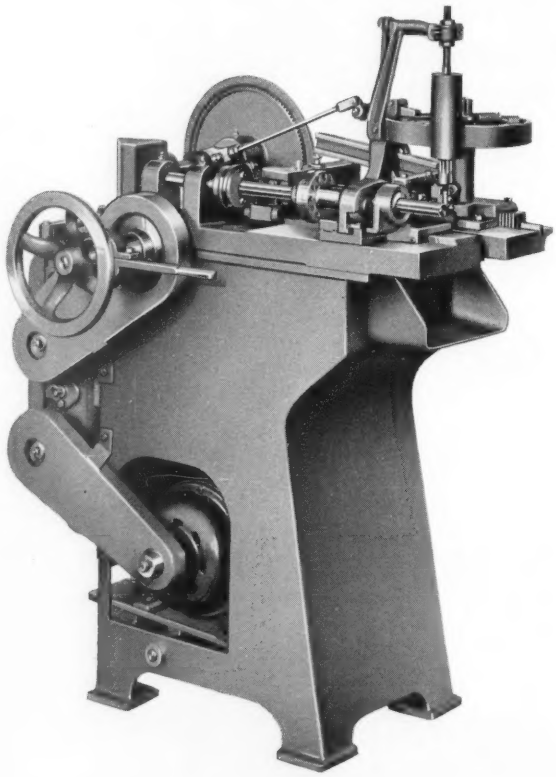

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Vol. 13 OCTOBER, 1938 No. 10

Resilience of Springs

By Rodman R. Tatnall,

Metallurgist, Morgan Works,

Wickwire Spencer Steel Company, Worcester, Mass.

Resilience is an important property of materials, and particularly important in the case of wire. The many varied applications of wire demand in almost every case a capacity for work, either in some form of spring action, or in resistance to impact, fatigue or elastic failure. It is essential therefore, that the wire user have a clear understanding of resilience, in order that wire may be applied in accordance with sound engineering principles. The wire maker should also be familiar with this subject, in order to appreciate the demands made on his product. ✦ ✦ ✦

Definition of Resilience

TO the average wire man, resilience means the "springiness" of a material, or perhaps its toughness. The term is used as a rather vague and indefinite designation of a property possessed in a widely varying degree by different materials. In technical language, the term is given a very definite meaning, relating to the elasticity of the material. Elasticity is the property of springing back, or resuming shape after a deflection. Resilience is the technical measure of elasticity.

✦ ✦ ✦

THE definition of resilience may be given as the recoverable energy stored in a material by means of a deflection. Deflection of a body involves a force, and in causing a deflection work is done on the body. Resilience is the amount of work the body can do when the force is removed. If the action is wholly elastic, the amount of work obtainable from a body is the same as the amount of work done upon it, except for some minor factors which are usually negligible in practical cases. In the case of plastic deformation, or deflection above the elastic limit, the amount of work recoverable is not the same as the deforming work, because of the permanent set introduced.

RODMAN R. TATNALL

Born in New Rochelle, N. Y., in 1906. Educated at Worcester Polytechnic Institute. First employment one year in Development Dept. of Waltham Watch Co. In 1928, joined Wickwire Spencer Steel Co. in spring production dept. In 1930, was promoted to position of Metallurgical Engineer, and since then has been in charge of experiment and research on spring and spring materials. Member of Wire Association and American Society for Metals.

EVERYONE knows what we mean by work, but again the technical language gives a special meaning to the word. By the technical definition, work is the product of a force and the distance through which it moves. This may be the raising of an elevator weighing 1 ton ten stories, or it may be ¼" deflection of a helical spring by a load of 1 pound. The former is a case of work against a dead load, and the latter a case of work against an elastic body. In elastic motions, unlike the dead load type, the force is not constant, but increases with the amount of motion. Since the load-deflection relation in this case is a straight line function, the mean load, (½ the maximum load), times the total motion gives the amount of work.

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Derivation of Resilience

THE nature and usefulness of resilience have been derived from its relation to the load-deflection diagram of an elastic body acted on by a force. In Figure 1 is shown a typical load-deflection diagram for a tough, elastic material. If we apply loads to a body made of such a material, and measure the deflection caused by each load, increasing the amount of load at each application, we will get a set of figures which can be plotted to

give the diagram shown. From this diagram, we can determine elastic limit, by means of the departure of the curve from the straight line, or perhaps from information given by the actual measurements.

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LET us assume a body whose load-deflection curve is shown by Figure 1. We have determined its elastic limit to be at point A. This point corresponds to a load of F pounds, and a deflection of B units. Now, the force acting during this deflection varied from zero to F pounds. The mean load is then F/2, and the work done is F/2 x 0B. Inspection of the diagram shows that this equals the area of the triangle OAB, or the area under the curve up to the point A. Since we know that A is the elastic limit, the unloading curve, for all practical purposes, will retrace the loading curve OA, and the body will give up the same amount of work as was put into it. In other words, in the wholly elastic motion, the resilience equals the area under the curve up to the point of highest load.

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IF we should increase the load to an amount G, the deformation then extends along the curve to the point C, with a motion of E units. The elastic limit has been passed, and again the work done in accomplishing this deformation is the area under the curve, enclosed by the lines OACE, which, in this case, can not be calculated very easily. Upon unloading, the curve CAO will not be retraced, but a new line, practically straight and parallel to OA will be found, shown by the line CD. Zero load will leave the body in the position D, and the distance OD represents the permanent set due to exceeding the elastic limit. The energy returned from the deformed body in this case equals the area under the line CD, which shows the new elastic motion.

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IT will be noted that the area OACE is very much greater than DCE. This means that the

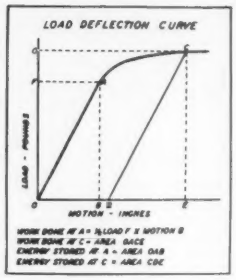
LOAD DEFLECTION CURVE
LOAD - POUNDS
MOTION - INCHES
WORK DONE AT A = ½ LOAD F X MOTION B
WORK DONE AT C = AREA OACE
ENERGY STORED AT A = AREA OAB
ENERGY STORED AT C = AREA CDE

Fig. 1.

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work of deformation is much greater than the work given up when released. The difference is absorbed in the atoms of the material and lost as heat. It will also be noticed that area DCE is greater than OAB. This is due to a strengthening of the material and a raising of the elastic limit by the partly plastic deformation occurring in the region AC of the curve.

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A CURVE of this type can be developed for any body under elastic motion, no matter how loaded, or in what manner deformed. Glass, cast iron, and extremely hard steel have some degree of elasticity, but very little toughness, and show no plastic deformation. Any material tough enough to form and work into springs will give a load-deflection curve similar to Figure 1, by proper plotting of force and deflection, no matter what the shape of the piece.

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Stress

DIAGRAMS such as the foregoing are often presented in terms of stress and strain. Strain of course, is deflection or deformation. What then is stress? Stress

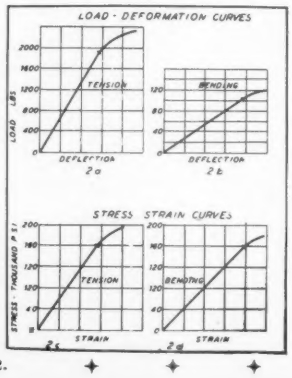

Fig. 2.

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is defined as the reaction of the particles of a body to a force acting on the body externally. For our present purpose, stress may be considered a common denominator, a calculated value which enables us to compare the effect of a load applied in one way with the effect of a load applied in some other way. In Figure 2 we have some diagrams for the application of a load in tension, and in one form of bending. (a) and (b) show the load-deflection curves from tests on identical material. Here the elastic limit in tension is found to be 1870 pounds, and in bending, 112 pounds. This is a remarkable difference for two tests on the same material. However, by means of established formulas for these two types of loading, we can translate loads into stress values, and re-plot the curves. The result is shown in (c) and (d) of Figure 2. It is readily seen that the elastic limit occurs at the same stress value in both cases. The difference in load at the elastic limit arises from the difference in manner of loading, as will be explained later. From this discussion, it is apparent that the calculation of stress values is necessary to give a common basis for comparisons.

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Formulas

THE resistance of a body to deformation by a force is determined by the shape of the body and the manner of application of the force. Stiffness is often confused with hardness or strength. However, within the elastic limit, stiffness depends solely on dimensions and type of loading, and not at all on hardness. What this stiffness will be in any individual case, for any certain material, can be determined with the help of established formulas which are easily found in hand-books or text-books. Stress values also can be calculated by formulas in common use, although complicated shapes give rise to formulas either difficult to use, or not very accurate in their results. These strength of materials formulas are the foundation of all design work.

FIGURE 3 is a table of various formulas covering different conditions of simple loading, and including round and square sections, as commonly occur in springs. First is given the mathematical relation between load and stress, and second, the stiffness of the particular type of loading, that is, the load-deflection relation. With these two formulas, we can find the load for any given stress value, and the motion under the action of this load. Then we can readily find the resilience, or the available work stored in the body, provided that the stress we have chosen does not exceed the elastic limit. By combining these two formulas, a single formula for resilience in terms of stress may be obtained, in which the value of the elastic limit may be substituted, giving directly the maximum possible resilience of a material in some particular use.

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IF we pick out the terms in the resilience formulas which make up the volume of material, and replace them by V, we get the formula shown in the last column, which is known as the Modulus of Resilience of the particular type of use. This is especially useful in comparing different uses of a material. For example, we can see immediately that, everything being the same, the resilience in bending, for round wire, will be 1/12 of that in tension. The resilience of a helical spring is the same as the same volume of material in pure torsion, in spite of the forbidding look of the spring resilience formula.

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SPACE does not allow any explanation of the origin of these formulas. However, the constants E and G appearing therein require some explanation. These two constants are the moduli of elasticity, E in tension, and G in torsion or shear. Different materials have characteristic values for E and G, those for some common spring materials being shown in Figure 4. Also shown in this table are other physical properties, based on commercial material, and

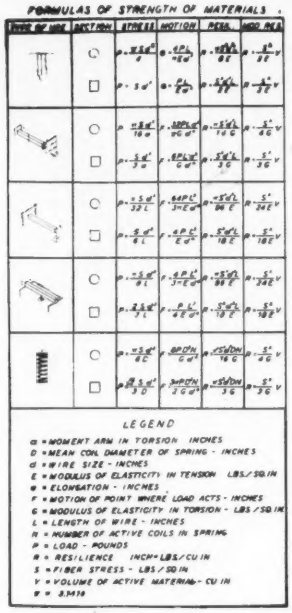

Fig. 3. ✦ ✦ ✦ ✦

applicable to No. 11 size, (.120″). Since physical properties may vary widely due to size, treatment, analysis, etc., these values should not be taken as standard for spring materials, but rather only as par-

REPRESENTATIVE PHYSICAL PROPERTIES
SPRING MATERIALS — BASED ON .120" DIA

MATERIAL	TENSILE STRENGTH	MODULUS E	MODULUS G	ELAS LIM TENSION	ELAS LIM TORSION
STEEL OIL TEMP. 85 C 85 Rc	220 000	28 000000	11200000	165 000	100 000
STEEL HARD DRAWN 65 C 100 Rc	200 000	28000000	11200000	130 000	70 000
STEEL NO 18 STAINLESS 18 CR - 8 NI	210 000	27 000000	10600000	140 000	85 000
MONEL 70 NI - 30 CU	145 000	26 000000	9 000000	80 000	55 000
BRASS SPRING 62 CU - 8 ZN	130 000	15 000000	6000000	80 000	>0 000
SPG BRASS 72 CU - 28 ZN	120 000	14 500000	5 500000	60 000	30 000

Fig. 4. ✦ ✦ ✦ ✦

ticular cases to which we shall have occasion to refer later.

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Interpretation of Formulas

THE meaning of these formulas can perhaps be made clearer by the comparison of numerical examples. For this purpose, we will assume a size of wire of #11, and a length of 1″ for the sake of simplicity. Using the properties given in Figure 4, we can then calculate loads, motions, and resilience under various conditions.

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EFFECT OF TYPE OF LOADING

.120" DIA UNIT LENGTH				
FIBER STRESS	2200	72600	147000	36800
MOTION	.000078"	.105"	.0392"	.03125"
WORK DONE	.0097	1.362	.365	.288

Fig. 5 ✦ ✦ ✦ ✦

I. Type of Loading

FIGURE 5 shows the results of such calculations for various types of loading. This brings out clearly that the amount of fiber stress, and the amount of motion both vary widely with the type of loading, since identical material is considered, and the only variable is the method of applying the load. Since the amount of fiber stress is limited in design by the elastic limit of the material, the method of applying the load determines largely the amount of work that can be obtained from a material.

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ANOTHER comparison is interesting at this point. Let us suppose it is required to provide a motion of 1/8″ under a load of 25#. In each type of use, the material should work near its maximum allowable stress value, for the sake of economy, and we find that in tension, this load can be carried by a wire .014″ in diameter. To give 1/8″ motion, a length of wire of 21.2″ will be required. If we are to do this work with material in torsion, a wire .109″ in diameter will be required, with a length of .76″. If bending of the cantilever type be used, the diameter will have to be .156″, and the length of wire 2.43″. In the case of the beam with center loading, the wire diameter required is .113″, and the length, 3.75″. If a helical compression spring is resorted to, assuming 1/2″ diameter of coil, the wire diameter will be .068″, and the free height of the spring, 3/8″. It will readily be seen from these comparisons that in design considerations, a wide variety of space must be provided, depending on the method chosen for doing the required work. The utility of the helical spring is readily understood from a comparison of its compactness and its economy of material.

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II. Shape of Section

FIGURE 6 presents two identical uses of material, in which the cross section of one piece is round,

and the other square. The same load is supported in both cases, and calculations show a lower stress value in the square section, and also a smaller motion, resulting in less work for the square section. However, the square section can carry a greater load with the same stress value as round wire, enough greater to cause an amount of motion equal to that of the round section. This is shown in the second set of figures under the square section. Since there is greater load capacity in square wire for equal motion, the amount of work obtainable from square wire is greater than that given by round.

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III. Material

VARIOUS spring materials have a wide range of physical properties, such as hardness, strength, elastic limit, etc. These properties affect the usefulness of such materials, the particular elements we are interested in being elastic limit and modulus of elasticity. Elastic limit is the well known property varying in different materials according to analysis, heat treatment, and other factors. Modulus of elasticity is a characteristic property of any particular material, similar to specific gravity. It is the constant of proportionality appearing in **Hooke's** law of elasticity, and has a different characteristic value for each material. Elastic motion in tension or bending gives a different value (E) than elastic motion in torsion or shear (G). This constant affects the stiffness of a body when acted upon by a force.

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FIGURE 7 shows two applications of material, carrying the same load, and calculations are given for the same dimensions of steel, brass, and monel metal. It will be noted that the stress figures in each case are identical, since fiber stress is entirely independent of the nature of the material. Deflection figures are quite different, however, because the modulus of one material is different from the other. The motion for brass is about twice as great

EFFECT OF SECTION

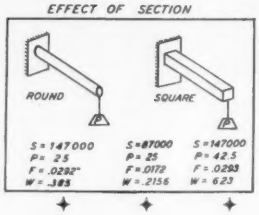

Fig. 6. ✦ ✦ ✦ ✦

as for steel, because the modulus is about one-half. Hence the work, or resilience, is twice as great under equal loading. For monel metal, the motion and resilience are not very different from steel because the moduli of these two materials are not very different.

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Capacity for Work

IT may have been noted in the foregoing examples that in some cases fiber stress resulting from the load chosen was very much less than the elastic limit.

EFFECT OF ELASTIC MODULUS

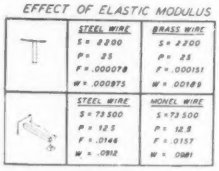

Fig. 7. ✦ ✦ ✦ ✦

MAXIMUM WORK CAPACITY
120° DIA. UNIT LENGTH

TYPE OF USE	SECTION	MAT'L	LOAD	MOTION	WORK
	○	STEEL	1870	.0038	5.5
		BRASS	480	.00413	1.4
	□	STEEL	3260	.0038	7.0
		BRASS	865	.00413	1.78
	○	STEEL	34.0	148	2.52
		BRASS	10.2	.091	.483
	□	STEEL	57.8	148	4.28
		BRASS	17.3	.091	.780
	○	STEEL	28	.0327	.457
		BRASS	10.2	.023	116
	□	STEEL	47.5	.0327	776
		BRASS	17.3	.023	.199
	○	STEEL	113	.0082	457
		BRASS	40.9	.0057	116
	□	STEEL	190.	.0082	776
		BRASS	69.1	.0057	199

Fig. 8. ✦ ✦ ✦ ✦

MODULUS OF RESILIENCE
VARIOUS MATERIALS - VARIOUS USES

TYPE OF USE	SECTION	STEEL WIRE 72 M.P.	STEEL WIRE 10-8	STEEL WIRE MD. OR	MONEL	PHOS BRONZE	BRASS
	○	485	362	302	123	214	124
	□	485	362	302	123	214	124
	○	223	171	108	84	104	61
	□	297	228	145	112	139	55
	○	40	30	25	10	16	10
	□	54	40	33	14	24	14
	○	40	30	25	10	16	10
	□	54	40	33	14	24	14

Fig. 9. ✦ ✦ ✦ ✦

This occurred because the load was deliberately taken so that in no case did the stress exceed the elastic limit. Obviously, in those cases shown with low stress values, more load could be carried, and more work done. The greatest possible amount of work for each case can be determined by assuming a fiber stress equal to the elastic limit, and calculating the load and motion corresponding. Again using .120" size and assuming unit length in each case, these calculations have been made. The results are shown in Figure 8, giving the maximum load, the resulting motion, and, from these two figures, the amount of work, or resilience.

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CALCULATIONS for two materials are given, since the amount of work is influenced by the maximum load, and also by the attendant motion. The maximum load is determined by elastic limit, and the deflection under this load is influenced by modulus of elasticity. Thus there is a double variation in the resilience from one material to another. Brass has the lowest elastic limit, compared with steel, of the common spring materials, and it also happens to have the lowest modulus. Hence, steel and brass were used to show the extremes of the list of ordinary materials.

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ANALYZING the range of values of possible energy stored, in these examples, we find a range from 7.0 in-lbs. for square steel wire in tension to .116 in-lbs. for round brass wire in bending. The explanation of these differences is found in the differences in type of material, and, having much greater effect, type of loading, shape of section, and elastic limits of the materials.

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Modulus of Resilience

THERE is another element in the figures shown in Figure 8 which must be considered in a strict comparison of materials. This is the element of volume of material. Modulus of Resilience, as shown in the formulas of Figure 3, is determined by maximum

stress and modulus of elasticity, with unit volume of material. Previous examples have not been based on unit volume of material, but on a specific volume made up of unit length and .120″ diameter, a volume of .0113 cu. in. Based on the formulas of Figure 3, and the properties shown in Figure 4, Modulus of Resilience has been computed and is shown for steel and brass in Figure 9. For round steel in tension, we have a maximum resilience of 5.5 in-lbs. from Figure 8, for a volume of .0113 cu. in. For 1 cu. in., from Figure 9, we find 485 in-lbs., which checks with the above figure when the proper allowance is made for volume.

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AS a summary of the foregoing considerations of modulus and capacity, Figure 10 shows for the particular case of torsion, the load rating given by various materials. This is based on the load required to produce 1″ of motion, although it will be noted that in no case is this amount of motion actually attained because of the load limit (elastic limit) for each material. The chart illustrates clearly the differences between these materials, the angularity of the lines being the influence of modulus of elasticity, and the elastic limit determining the maximum load capacity. If the area under each line at the elastic limit be pictured, it will be readily seen that both load rating (modulus) and maximum load (elastic limit) determine the amount of work obtainable.

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AN element of importance in the use of modulus of resilience is the fact that elastic limits of many spring materials vary with size. Thus, for an oil tempered wire, the figure shown in the table as modulus of resilience for .120″ wire is 28% high for ¼″, and about 20% low for .080″. The solution to this difficulty lies in the determination of modulus of resilience for each individual case, using the proper formula to fit the type of loading, and the correct physical properties of the particular wire under consideration, both size and material. The presentation of any comparison of materials on this basis is too complicated to be practical here. However, in Figure 11, the case of torsion, applying also to helical springs, is illustrated for steel spring wire, to

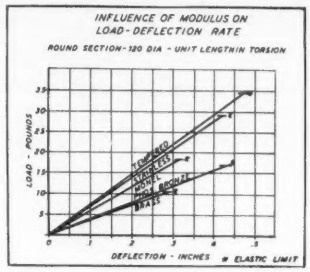

Fig. 10. ✦ ✦ ✦ ✦

show how the variation in physical properties in different sizes works out. This brings out clearly that as the wire size changes there is considerable change in the maximum work obtainable from unit volume. However, it must be noted that this increase of work may result from greater motion, or from greater load. As a matter of fact, a smaller wire has less load carrying capacity, and greater

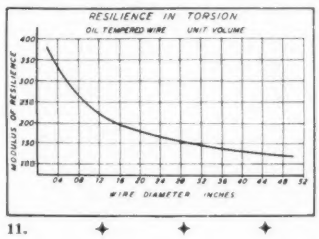

Fig. 11. ✦ ✦ ✦ ✦

motion. Coupled with higher elastic limit, these factors give a net result of greater capacity for work. Unfortunately we can not always take advantage of the full capacity, because of the particular combination of load and motion required, or because the work capacity is made up of a small load and a motion far too large for practical use.

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IN the case of the non-ferrous materials, there is much less variation of resilience with size, due to the fact that the manufacture of these wires produces almost no variation in physical properties of different sizes, compared with steel wire.

Resilience in Design

THE value of our knowledge of the physical properties of materials lies in the use we can make of them for design purposes. When we calculate loads and deflections, stiffness, or working stresses, we make use of the known properties of the material we want to consider. In reality, we make use of the elements that go to make up resilience, without actually, in most cases, calculating the value of resilience. Should we work from the other end, that is, determine the modulus of resilience and then attempt to work out our design from this, we would have a much more cumbersome design procedure.

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THE reason for this is two fold. The modulus of resilience does not give us any indication of dimensions, but only volume. This volume may be distributed in an infinite variety of dimensions. Further, the resilience, or work, may result from an unpredictable combination of load and motion. Consequently, since design is concerned with dimensions to give definite load and motion, resilience as a guide in these determinations is not very useful.

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THERE is one feature of the resilience of a material which is quite useful, and that is the fact that the volume of a certain material required to do a certain amount of work can be determined. This is advisable, especially in preliminary designs so that proper dimensions can be given to related parts to provide the required space for the wire part.

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Comparison on Cost Basis

ANOTHER element in the choice of material besides its capacity for work is its cost. It so happens that the material with the greatest capacity is the cheapest, but for various reasons, more costly materials may be required. The final choice must always be a balance between the ability to do work, other properties such as corrosion resistance, and cost.

IN order to illustrate the influence of cost in the choice of materials, an ordinary helical compression spring has been taken as an example. If this spring be made to identical dimensions using a variety of materials, we can, by calculation, or by actual test and measurement, determine the loads these springs will hold, and the corresponding motions. We can then find the work done by each spring, and compare this with an estimate of cost for each material. Figure 12 shows, in chart form, the result of such an analysis.

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IT will be seen that the maximum loads decrease for different materials, in the order listed. Corresponding motion is approximately the same in each case, because of the difference in moduli. It so happens that the free length and solid height chosen give a maximum motion in the spring nearly the same as the allowable motion for each material.

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THE amount of work done in each case decreases with different materials, as would be expected from the decrease in loads. However, it is interesting to note that Phosphor Bronze and Brass show more work available than does Monel metal, in spite of the lower load. This is because of the differences in moduli, giving greater motion for Brass and Bronze.

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THE cost index shown does not represent manufacturing cost, but is based largely on the material in question, and is for the sake of comparisons only.

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FIGURE 13 shows a chart of a similar comparison, this time considering springs made of different materials, designed to do the same amount of work. To do this it is necessary to vary the dimensions, that is, change wire size, outside diameter, and number of coils. There is then considerable difference in the volume of material in each spring, and in the relative cost. The comparisons of volume between ferrous and nonferrous materials is of importance in cases where changes are made from one material to another, as mentioned previously. The other relations are similar to those shown in the previous chart, and need no further comment.

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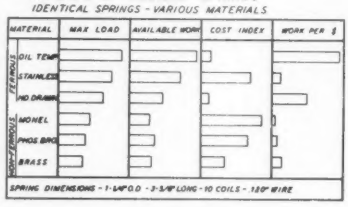

Fig. 12. ✦ ✦ ✦ ✦

Other Considerations of Resilience

NOTHING has been said so far concerning the building of resilience into wire. This is a subject for an entire paper in itself, but it may be said that the resilience of a wire results directly from the physical properties of that wire. As we improve physicals, we improve resilience. This improvement results from higher load capacity, and not from any change in modulus, or in the mechanics of the use of the material. There is a continuous striving to improve physical properties, usually by increasing strength. However, some degree of workability, that is, toughness or ductility must be retained. Thus, the hardness, and hence the resilience, is limited by the toughness required for working the wire into the form in which it is to be used.

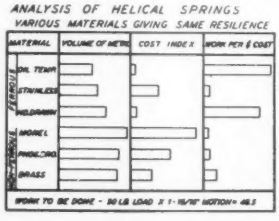

Fig. 13. ✦ ✦ ✦ ✦

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THERE is another factor which influences the maximum resilience offered by a material, and that is the question of fatigue. In most helical spring uses, for instance, tests show that the endurance limit of the material is considerably less than the elastic limit. For example, the endurance limit of an oil tempered wire in torsion has been found at a stress roughly 2/3 of its elastic limit. Hence, if entire freedom from fatigue failure is desired, the maximum resilience must be determined by the value of the endurance limit, not from the elastic limit. In the case cited, instead of 223 in-lbs., as previously shown, the maximum resilience under fatigue considerations will be 98 in-lbs.

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SUFFICIENT information is not available to give accurate comparisons of various materials on this basis, but it is a factor that should be considered in many cases.

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Summary

A SUMMARY of the foregoing discussion may well emphasize the following points.

1. **Resilience is the energy of an elastic motion available to do work when the deflecting force is removed.**
2. **The amount of energy available to do work as resilience depends on the amount of work done on a body, which in turn depends on the magnitude of the force acting and the motion it produces. To recover all the energy stored in a body, the motion must be wholly elastic.**
3. **The amount of motion imposed on a body by a force depends on the magnitude of the force, the shape and dimensions of the body, the type of motion occurring, the method of applying the force, and the material of which the body is composed.**
4. **Application of a force to a body sets up stress in the body. Elastic limit is the stress value which limits the force to a wholly recoverable amount. Endurance limit is the stress value which marks complete freedom from fatigue failure.**
5. **Comparisons of materials for elastic use may be made by means of Modulus of Resilience. This modulus depends on type of material, its elastic limit, and on the type of loading involved.**
6. **The usefulness of spring materials is limited by their elastic properties. In many cases, their usefulness may be limited by fatigue properties or other factors. In any case, usefulness must be weighed against cost.**
7. **Physical properties, notably elastic limits, determine the maximum resilience of a material. Increased elastic limit means increased resilience, but the amount of practical increase is limited by ductility requirements.**

(Please turn to Page 614)

The Kind and Necessity of Tests for Rope Wire

By H. K. Hammerstein,
Chief Engineer,
Broderick & Bascom Rope Co., St. Louis, Mo.

A brief description of the kind of tests to which rope wire is subjected; their importance in reflecting the desired properties, and the reasons for the need of further investigations.

SOME of the things that are most important to our well-being and safety, are taken for granted by the average person, without any thought for the care and research back of its development and production.

✦ ✦ ✦

ONE of these things is 'Wire Rope'. Without this strong, flexible piece of machinery it is doubtful of we would have many of the things now accepted as necessities. For example, the skyscraper is habitable only because of the high-speed elevators, which in turn depend upon the hoisting ropes; and the production of crude oil is made much easier and cheaper because of wire rope. In large and small diameters, wire rope enters into the production and manufacture of virtually every commodity in use.

✦ ✦ ✦

THE name 'Wire Rope' is given to a product consisting of Iron or Steel wires twisted together into strands, and these strands, most often six in number, in turn twisted together around a core, the latter usually consisting of hemp, or some combination of wires. It is possible to make over three thousand different varieties of wire rope in any given diameter by combinations of various numbers of wires per strand, various grades of wire in the strands, various types of fiber and wire cores, and a number of combinations of direction of twist, etc. However there would be so little difference in the majority of these, that for general purposes, only about 50 to 75 kinds are usually made, and, depending upon the diameter, fewer carried in stock.

Wire Quality

OF major importance to the wire rope manufacturer is wire quality. I believe all rope manufacturers will agree that a wire rope made with the utmost care out of a poor or inferior quality of wire has no more chance of giving satisfactory service than a rope carelessly made out of good wire.

✦ ✦ ✦

THE terms 'good' wire and 'poor' wire are very general,

H. K. HAMMERSTEIN

Educated at Washington University in Civil Engineering, and entered the employ of Broderick & Bascom Rope Co. in 1916 as draftsman in their Engineering Department. Successively designer and Construction Superintendent of small Suspension Bridges and Aerial Tramways. Then transferred to Sales Department for 5 years, and in 1927 assigned to St. Louis Factory Testing Department. In 1929 made Assistant Superintendent of Factory, and since 1931, Chief Engineer.

and a more specific outline of what each constitutes, insofar as wire rope is concerned, follows.

✦ ✦ ✦

THE first thing usually specified in wire is the size, or diameter. The general adoption of tungsten carbide for wire drawing dies has virtually eliminated out-of-round, scratched, and tapered wire, and has enabled the wire mills to produce wire in all sizes with a plus and minus tolerance that was formerly only possible in those sizes drawn with diamond dies. Not so very long ago the size tolerance for .050″ wire, the size used in, say, a ¾″ 6 x 19 filler construction rope, was about .0015″ minus, and .002″ plus. We now consistantly receive wire of this and much larger diameters, in which the size variation between the largest and smallest wires of the lot is no more than one-half a thousandth. Hence the wire rope manufacturer can now produce successive ropes of the same specified size and construction with a much greater degree of uniformity than was possible some years ago.

✦ ✦ ✦

THE finish, or surface condition of the wire has also been considerably improved, which undoubtedly has also contributed to greater tensile strength uniformity, and increased torsions, bends and elongations. It is evident that the study and investigation to improve the finish, which is being made by the wire producers along the lines of better surface on hot rolled rods and billets, scale elimination during patenting, type of drawing lubricants, and kind of

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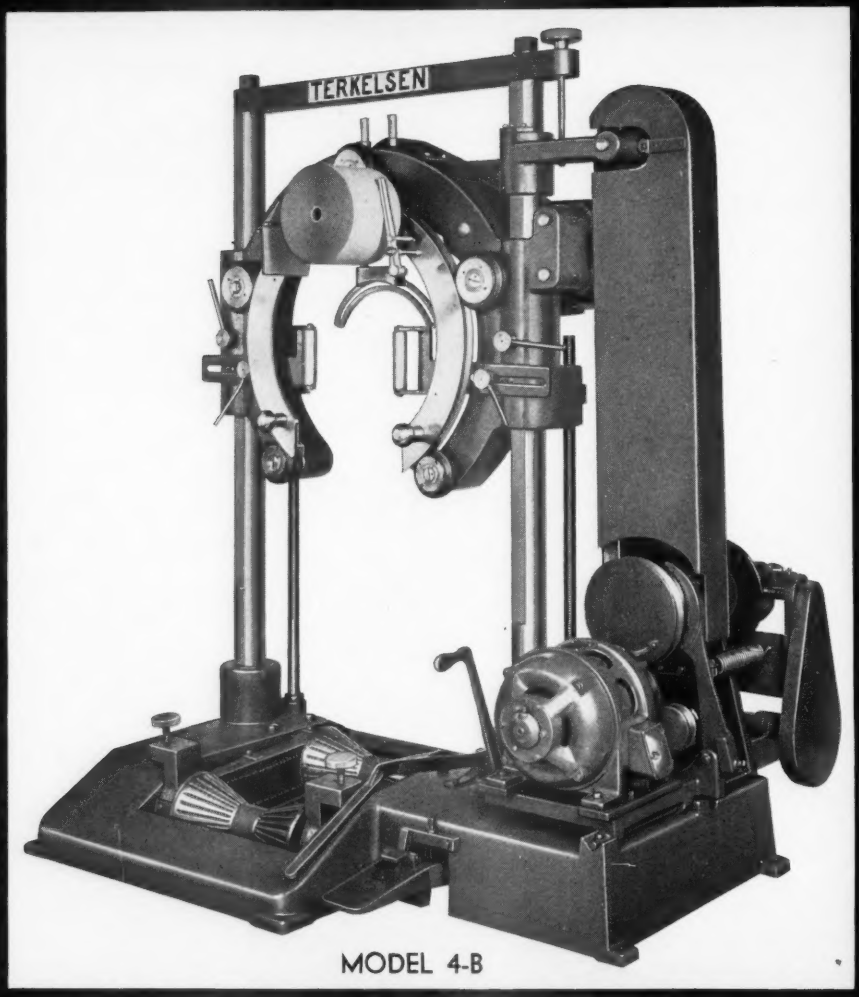

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finish, etc., will result in further improvement of the physical properties of rope wire.

✦ ✦ ✦

Tensile Strength Ranges

THE tensile strength of wire intended for wire rope usually determines its grade classification. Briefly, the four grades most extensively used for rope wire, and their approximate tensile strength ranges, are, (1) Caststeel, 170,000 to 195,000 lbs. per sq. in., (2) Extra Strong Caststeel or Mild Plowsteel, 195,000 to 220,000 lbs./sq. in. (3) Plowsteel, 220,000 to 245,000 lbs'/sq. in., and (4) Improved Plowsteel, 245,000 lbs./sq. in. and higher. Anent the Improved Plowsteel grade, each Rope Manufacturer may differ somewhat as to the most desireable tensile strength range, because for certain applications or in certain constructions, a tensile strength in the neighborhood of 300,000 lbs. per sq. in. might be considered most suitable.

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I THINK all rope manufacturers agree that the more nearly alike in tensile strength all like-positioned wires are, (not considering for the moment the other physical properties) the greater the likelihood of uniform wear, and the lesser the chance of random wires breaking. To illustrate this point with possibly an exaggerated example: In a lot of Plowsteel wire, in which the tensile strength ranges from 220,000 to 245,000 lbs./sq. in., a better rope will result if, say, all wires from 220,000 to 230,000 lbs./sq. in are grouped together for outside use, and all the remainder are grouped together for inside use, where the outside and inside wires happen to all be of the same specified size. Or, if all of the wire is intended for outside use, use it in different ropes. Such selective use of rope wire is becoming increasingly necessary, due to the severity of many of the usages to which the wire rope is being put, and the desire of the manufacturer to in every way improve it. High speed elevators, larger and faster shovels, and deeper oil wells, etc., are only a few of these increasingly severe applications. No doubt all wire producers are being asked, or it is being specified, to hold their shipments of wire to increasingly closer tensile strength variations, or the makers of wire rope find it necessary, after testing the wire of a certain grade, to sub-classify it.

✦ ✦ ✦

Tensile Tests

DURING the testing of the wire for tensile strength, it is needless to say that the appearance of the fracture often indicates its quality, and that 'cuppy' and 'brittle' wire is generally very noticeable. Figure 'A' is a photo of a good normal tensile fracture, while figure 'B' shows a typical 'cuppy' wire fracture.

✦ ✦ ✦

Torsion Tests

ALSO demanded by all wire rope manufacturers, and by many users of wire rope, is the Torsion, or twisting test of the wire. I believe the methods and equipment for making this test are familiar to all and a detailed description is not necessary. It is difficult to state exactly all the characteristics that this test is supposed to reflect, and its degree of importance. The emphasis given to the importance of this test has been questioned by some. It is generally accepted however, that the torsion test indicates the uniformity of the grain structure of the wire as well as its surface condition, besides measuring to a limited extent its ductility. Any local defects are also detected. The number of torsions that a wire will make can be materially controlled during its production by various means, but other physical properties are thereby also affected. For example, torsions and bends are oppositely affected by the grain size obtained by patenting. Hence when the torsion specification is to be met, due consideration must also be given to the bends. And also, drawing with light drafts (the final drafts) results in a relatively lower tensile strength, but higher torsions and bends, in the finished wire. Hence the number of twists by which a wire exceeds the prescribed minimum is important only when correlated with the other physical properties, with the manner in which the twists have formed, and with the appearance and nature of the fracture. To illustrate: Figure 'C' shows a wire which has twisted smoothly and

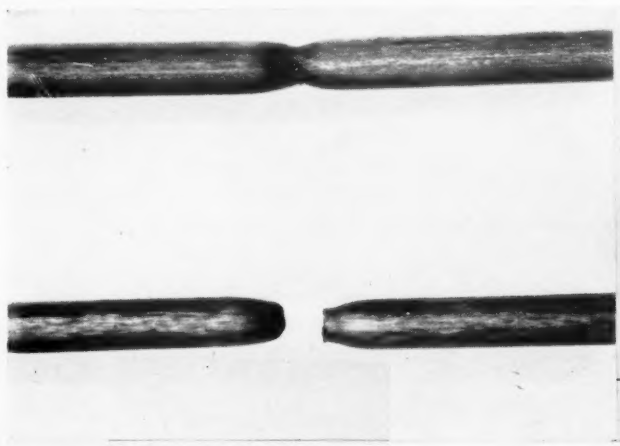

Fig. A. Good Tensile Fracture.

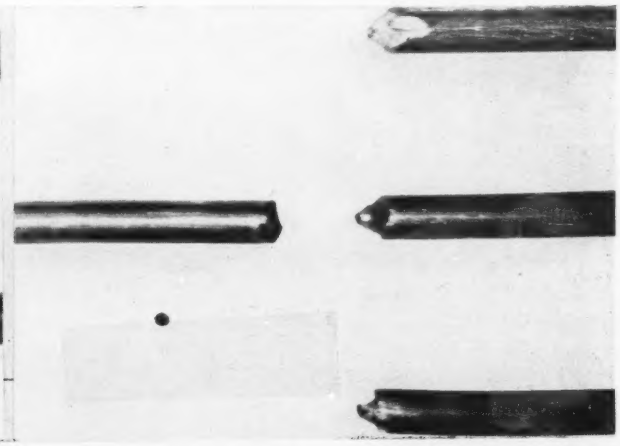

Fig. B. Poor Tensile Fracture.

evenly, and has exceeded the minimum requirements by two twists. Figure 'D' shows a wire which made very 'lumpy' twists, but before breaking, made one more twist than the wire shown in figure 'C'. To me, the coil of wire represented by specimen 'C' is much more desireable and suitable for wire rope than the coil represented by specimen 'D', in spite of the fact that the latter made more torsions. As a matter of fact, further tests of coil 'D' showed torsion failures, and it was rejected. It is also known that the number of torsions a cold drawn wire will stand is not proportional to its ultimate tensile strength. Variations of the standard torsion test have also been presented for consideration, among them being one in which the wire is alternately twisted to the right and then to the left; and another in which there is a combined twisting and bending. All of these have their merits, but it is doubtful if they will ever be universally adopted.

Fig. C. Good Torsion.

Fig. D. Poor Torsion. ⅝

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Bend Testing

THE bend testing of wire is perhaps the simplest test to make, and the one whose results may be most difficult of interpretation. Some specifications call for the wire to be bent around its own diameter for a specified number of wraps, and others for bends of 90° over mandrels of various radii. (In the latter test one bend constitutes bending the wire from the perpendicular to the horizontal, and back, at a specified speed and tension). I believe that the bend test is important in determining the suitability of the wire, for in actual usage as wire rope, the stresses set up in it are more in the nature of bends, than torsional. However, when made into rope, the wire has already been twisted into a double helix, and it therefore bends with varying loads at various speeds, and over various diameters. Bend tests of the wire seem valuable in that they afford a simple check on the ductility of the material, and in addition, like the torsion test, will reveal defects in wire not visible on the surface.

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Measuring Elongation

ELONGATION, or the amount of stretch in a wire before it breaks, is generally measured while the tensile strength test is being made. It is most commonly obtained by plotting a stress-strain diagram; with an Extensometer; or with one of several varieties of an Elongation Scale, and for rope wire is most generally measured in a 10-inch length. There is a growing belief that high elongation in the wire, relatively speaking, contributes materially to increased rope life.

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Elastic Limits

THE elastic limit, or the limit of proportionality, of steel is completely altered by cold drawing. Cold drawn wire is in fact, never perfectly elastic, there being a slight but definite departure from perfect proportionality of stress and strain at low loads. From the standpoint of rope application it is not a serious factor for consideration because the amount of permanent stretch even at loads near the breaking point of the rope, is negligible.

✦ ✦ ✦

The Yield Point

THE yield point is the point at which a marked increase in deformation occurs without any appreciable increase of load. In rope wire it is generally somewhere between 85% and 95% of the ultimate tensile strength, but for all practical purposes it may be said to coincide with the breaking load. In many instances this is recorded when the tensile strength and elongation tests are being made. It can be calculated from the stress-strain diagram, or noted while observing the extensometer reading.

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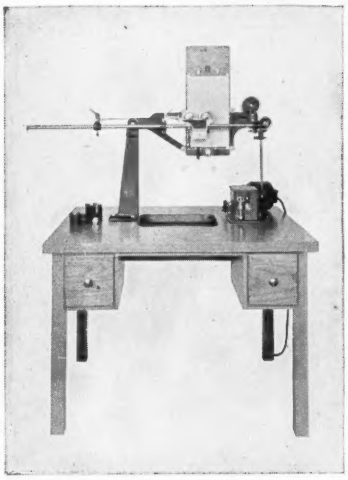
Fatigue Test

A TEST which occasionally is written into rope wire specifications, and one which possibly will become more common, is the endurance (fatigue) test. It seems as if this should be the most important test of all, but the time required to test a single wire precludes its being used very much as a routine test. Considerable work has been done both here and abroad to develop suitable testing devices and interpreting their results. Several papers have been presented in the past few years before the Wire Association describing equipment and procedure for making such tests, and the conclusions drawn from the results obtained. All of the latter, I believe, have dealt with the tests of an individual wire, and emphasized the fact that surface finish played a very important part in the ultimate results. Now when testing rope wire it would not appear correct to carefully polish each specimen before making the test as (1) that is not the condition in which it will be used, (2) because the specimen only represents a very minute portion of the coil, and (3) because after the first few minutes in service many of the wires may be nicked and scratched from rough sheaves or drums, etc. Hence for the present at least, an endurance or fatigue test seems to me as one to be used primarily by the wire maker as an aid in developing a process, and in steel selection, so that the finished wire will have maximum endurance, or fa-

tigue resistant, properties. To digress briefly; a wire rope in use has a breaking strength anywhere from 4 to 10 times greater than the maximum load that is to be applied. The reason for this is that some loss of strength always takes place due to abrasive wear, broken wires, etc., and also because in the past it has been found that ropes have failed in service after a period of work even though considerably less than the actual breaking stress has at any time been put upon it. It is known that there is a fatigue limit for all metals, and that metals will stand up more or less indefinitely provided that this limit is not exceeded. But once this limit is exceeded, permanent injury is done to the metal, and failure will only be a matter of a short time. It is also known that in the case of wire rope, there has been 200% to 300% or more, difference in service obtained from similar ropes, working successively on the same equipment, and to all intents and purposes, under identical conditions. The only difference in the successive ropes was that they were made of different lots of the same grade of steel, and reference to the original tests of the wire showed no differences other than normal. But there must have been a material difference in the endurance properties of these two lots of wire that was not discoverable by the standard and proscribed tests. Hence the need for a rapid and reliable endurance test, if the place for this test is on finished wire prior to fabrication. There are several methods for making fatigue tests on the finished rope, and when this is done it indicates relatively whether or not the rope has good or bad endurance properties, but only as compared to some other rope, of possibly a different construction. To test all rope this way would seem to be a rather expensive method whereby to condemn a rope, as, in the case of a rope normally made, fabrication apparently is a minor factor in controlling this characteristic. Therefore it would seem as if the necessary endurance, or fatigue testing must be done on the wire prior to fabrication. And, as inherent steel quality, patenting, drawing, and finish, etc., can all more or less influence this property, it appears as if it should be done by the wire producer in con-

(*Please turn to Page 633*)

SCOTT TESTERS



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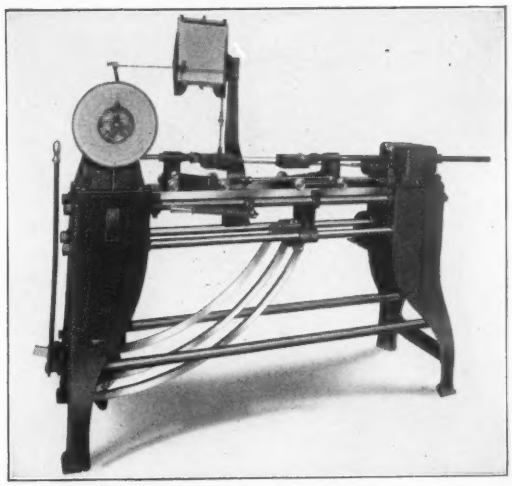

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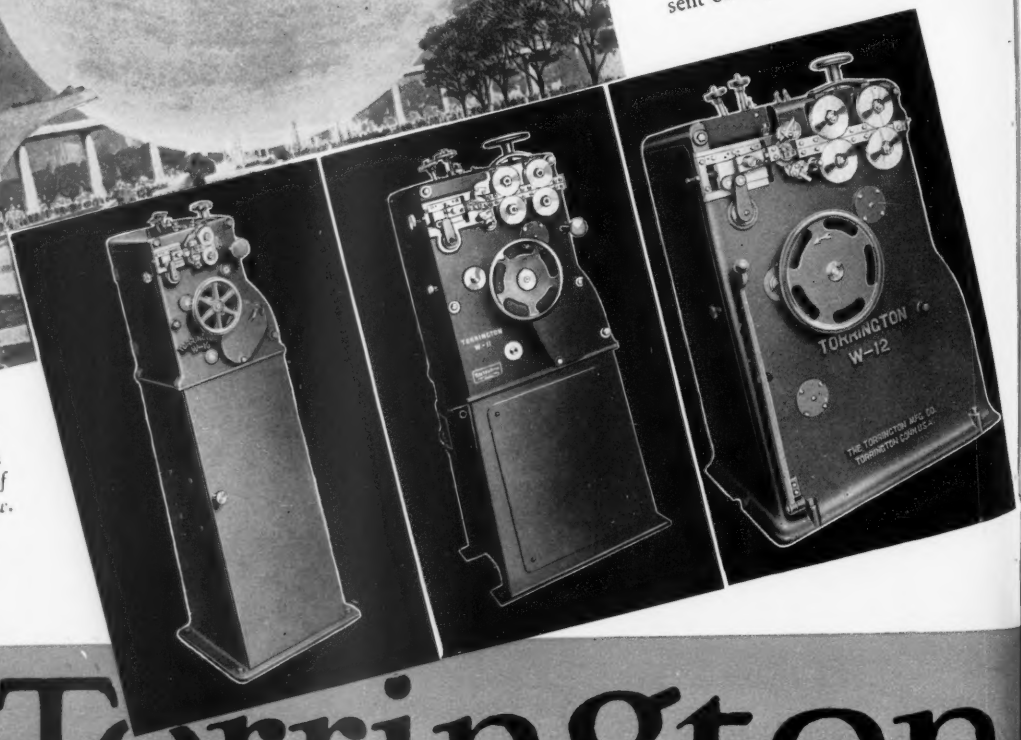

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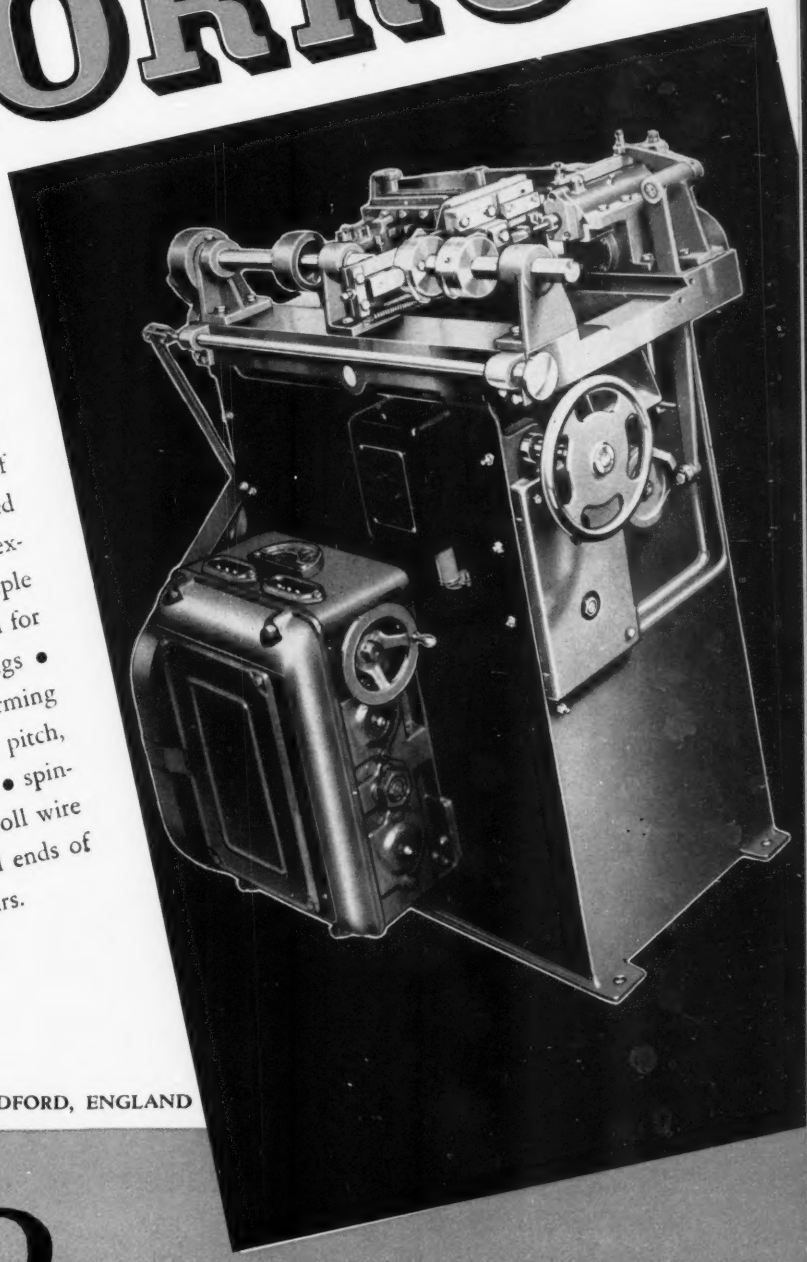

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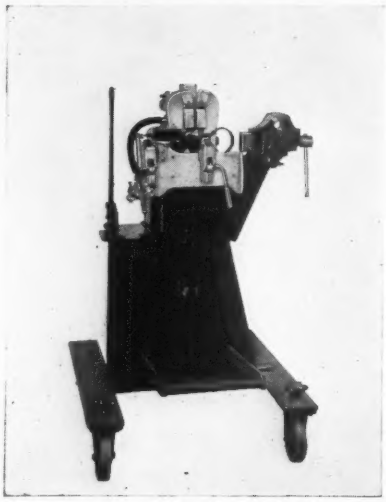

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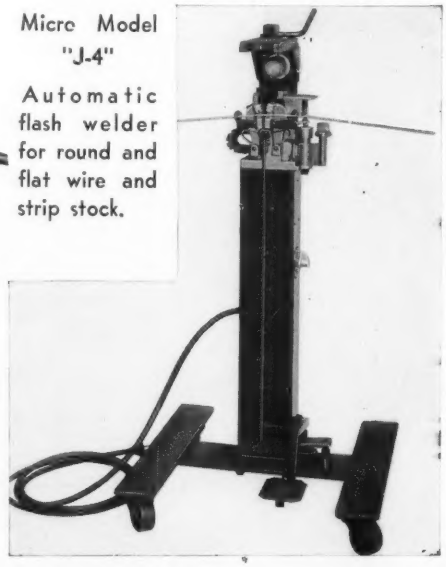

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Wire Cloth

Its Many Kinds and Uses

By Ralph B. Roth,
Purchasing Agent,
The Ludlow-Saylor Wire Co., St. Louis, Mo.

A discussion of the industrial uses of wire cloth, together with an outline of the various extremes in meshes and diameters available in steel, ferrous and non-ferrous metals. ✦ ✦

WIRE cloth, as a term, covers a very heavy grade which has clear openings of say, for instance, 4 inch made of a 1 inch rod. Of course, there are still heavier grades which can be made, such as 6, 8 or 10 inch opening made of as heavy as 1¼ inch rod or heavier. The other extreme would be a wire cloth made of 200 mesh or finer of a wire as fine as .0021″ diameter. 200 mesh wire cloth has 40,000 meshes per square inch. 400 mesh has 160,000 meshes or openings per square inch, which wire is comparatively smaller than the 200 mesh.

✦ ✦ ✦

NOW just for a moment, I will ask you to picture in your mind a space of 4 or 6 inches surrounded by a 1 inch or 1¼ inch diameter rod. Then, if possible, picture the opposite of 40,000 to 160,000 openings per square inch. Contrary to belief of many people, these two extremes and all the intervening ones are termed Wire Cloth.

✦ ✦ ✦

PEOPLE generally believe that cloth means a fabric woven of wool, silk, linen and cotton and such, and do not think that fabric woven of wire is called Wire Cloth.

✦ ✦ ✦

WITH this picture in your mind, I wish to proceed with some of the uses to which Wire Cloth is an essential. And this covers from the building of the houses you live in, the clothes you wear, and the food you eat.

✦ ✦ ✦

PLEASE remember it is almost impossible for me to attempt to explain all the uses of Wire Cloth, and therefore, will just enumerate some which may interest you. Sand, gravel, crushed stone, various chemicals, artificial silk, paint pigments, metallic and non-metallic, mining of all kinds. Spark arrester screens, food stuffs including cereals, fruit juices, filtration of various fluids such as gasoline, naptha, and in the manufacture of gasoline and oils, machinery guards, seed grading.

RALPH B. ROTH

Born Aug. 31st, 1888 at St. Louis, attended public and High schools later, Jones Commercial College, entered the employ of his present employer, (The Ludlow Saylor Wire Co.) June 16th, 1904, general clerical work. Entered in Purchasing Dept. Jan. 1st, 1918, and was made Purchasing Agent June, 1923. Elected a Director of the above Company, May 16th, 1930. Member of the St. Louis Chapter of Purchasing Agents. Member of National Association of Purchasing Agents. Member Wire Association.

Strainers of all kinds for industrial and household uses; in the Rubber Industry, Cement Manufacture, and many more applications.

✦ ✦ ✦

WIRE Cloth plays an active part in the comforts of your daily life, as feathers which give you the pleasure of a soothing sleep are renovated and sorted by the aid of wire cloth, and your breakfast of cereals and juices also have been screened. And during the intervening hours from morning to night many applications of Wire Cloth have played an important part.

✦ ✦ ✦

THE average citizen, for example, thinks first of insect screen cloth, and next of poultry netting, and possibly woven wire fencing, as the most prominent items classified under this heading. It is true that many years ago we made those prominent items, however, we do not make those items any more.

✦ ✦ ✦

Industrial Wire Cloths

THE items I work with and know about, are the group of weaves of various metals which are known as Industrial Wire Cloths and screens. These are grades which are used by industrial enterprises for innumerable purposes which average citizens never think about.

✦ ✦ ✦

AS an example, the average citizen eats breadstuffs and cereals daily; yet he never thinks of the millions invested in grain milling equipments, whose ultimate purpose is the bolting of final products through various wire-cloth meshes. Grain-milling and flour-milling equipment present some

very interesting problems of wire cloth application.

✦ ✦ ✦

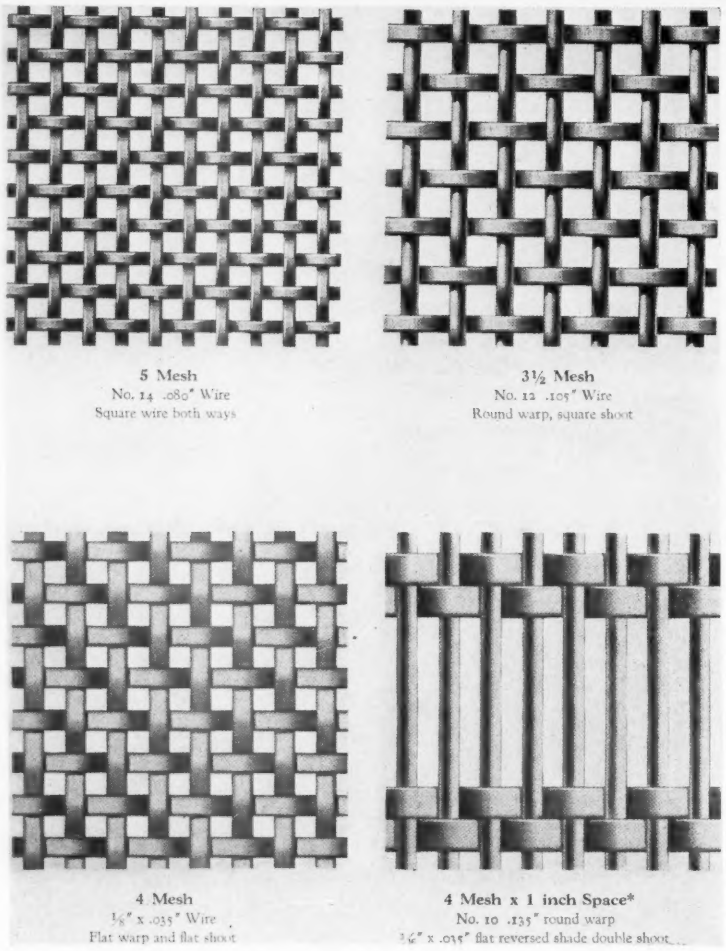
FOR many years most fine flours were bolted chiefly through silks, imported chiefly from Switzerland. These silks are spun and woven with suprising accuracy, and have an unbelieveable resistance to the abrasive action of grain husks and foreign matter. They present a satisfactory proportion of open active screening space per unit of sieve area, and for many years Swiss Silks were regarded as the finest bolting medium available to mill engineers. Their weakness lies in susceptibility to damage from insect pests always present in grains and cereals, and since the world war, when the milling industry experienced a tremendous increase in silk losses due to insects shipping in from Europe in empty flour sacks, the vermin proof qualities of wire cloth have created a great demand for various weaves and meshes.

✦ ✦ ✦

NATURALLY for fine bolting the wire cloths must be woven with the greatest uniformity and be absolutely free from broken wires, spread meshes or other structural defects. Wire of proper analysis and tensile strength is of prime importance, and uniform temper, composition, and preparation are indispensable if a uniform lasting weave is to be secured. Resistance to rust is also requisite and a high quality of tin coating is necessary for wires intended for grain-milling weaves. Various rust-proof alloys are also available and used.

✦ ✦ ✦

RICE-MILLING presents an opposite problem from flour milling, in that preservation of the grain in its original size and shape is desirable. The wire cloth is used in machines for brushing off the husks from the rice grains and separating the bran from the cleaned product. Here the chief problems are exact uniformity of weave, and maximum resistance to extreme abrasion. Wires of special analysis and temper are required, with suitable tensile strength so that finished weaves are absolutely free from breaks or imperfections.


5 Mesh
No. 14 .080" Wire
Square wire both ways
3½ Mesh
No. 12 .105" Wire
Round warp, square shoot
4 Mesh
⅛" x .035" Wire
Flat warp and flat shoot
4 Mesh x 1 inch Space*
No. 10 .135" round warp
⅜" x .035" flat reversed shade double shoot

"Four Combinations of round, square and flat wires." ✦ ✦ ✦

✦ ✦ ✦

IN flour milling the wire cloth is used to remove coarse particles and foreign matter from the fine product. In rice-milling the wire cloth is used to remove fine substances, bran and broken husks while preserving the original size of the grains as far as possible.

✦ ✦ ✦

A SIMILAR contrast of opposites is seen in the uses of Wire Cloths common in the mining industry. In the marketing of soft coal the value decreases with the size of the pieces of coal, and the problem in separation of friable coals is to sort them into various market sizes with a minimum of degradation, so that a customer may buy his desired sizes as free from dust and fine sizes as possible.

✦ ✦ ✦

BITUMINOUS coals are therefore sized over screens woven to have their upper surfaces as smooth as possible, so that the coal will slide over the smooth surface with a minimum of degradation due to tumbling or chipping against rough metal surfaces.

✦ ✦ ✦

IN metal mining the problem is the opposite. Metallic ores are ground to varying degrees of fineness for the purpose of releasing metal particles imbedded in the mineral mass. Uniformity of fine sizes is essential to further processing, and screens are required to pass through their openings the

maximum amount of fine sizes absolutely free from over-sizes. Over-sizes are not desired as such, and after passing over the screen these sizes are returned to the crushing or grinding system for further reduction. Extreme accuracy of weave is a problem in controlling fine through sizes and wire screens for this purpose must be free from breaks or imperfections and have maximum resistance to abrasion. Tensile strength, hardness, toughness and uniformity of molecular structure and temper are primary considerations in wire for mining screens.

✦ ✦ ✦

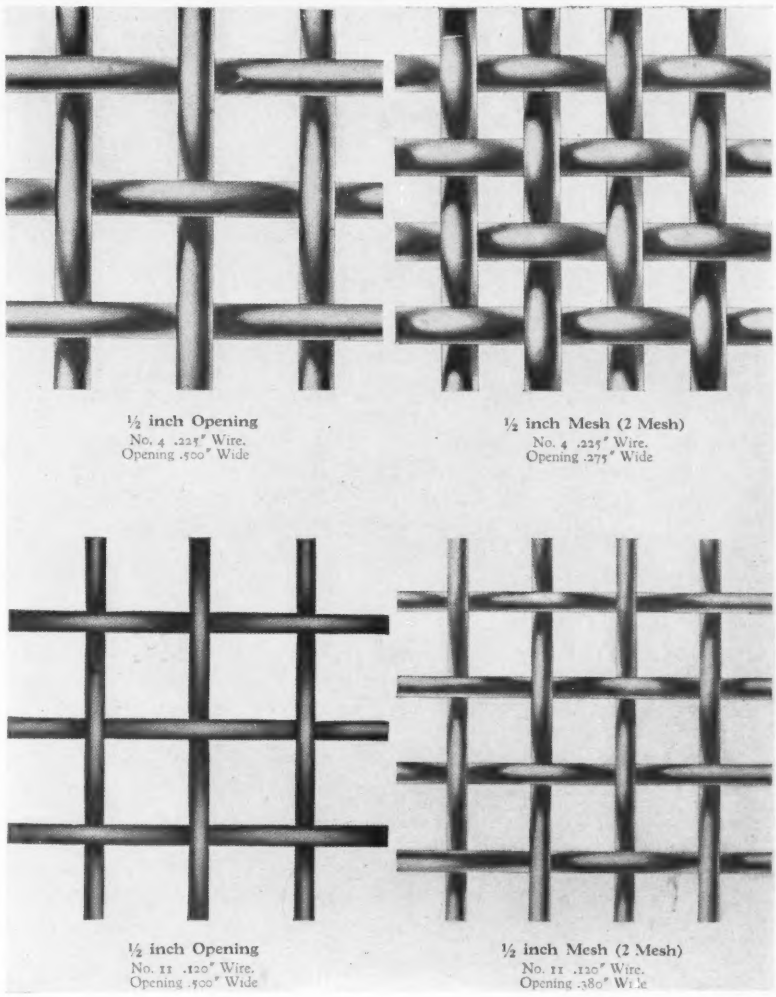
MODERN screening equipments have introduced tension and vibration as further destructive forces which wire screens must overcome. To secure maximum passage of fines through the screen, with minimum waste grinding from the return of satisfactory sizes to the grinding system, screens are subjected to intense vibration, at high frequency and maximum amplitudes. To improve the vibratory properties of the weave, each screen is stretched tight throughout its area by suitable tensioning devices, so that the metal in the wires is called upon to resist not only fabricating strains induced in crimping and weaving operations, but further combined destructive elements including abrasion, vibration, tension and the impact of large sizes frequently dropped upon the screening surface from considerable heights. In many instances the screening equipments themselves introduce further destructive effects such as sharp edges of tensioning devices, inequalities of tension or vibration, etc. In some few instances on vibrating screens resistance to corrosion is a further requirement, as for example in handling certain washed coals where the mine waters contain various acids and sulphur solutions and compounds.

✦ ✦ ✦

IN most weaves intended for use on vibrating screen equipments, the selection problem involves striking a balance between maximum resistance to destructive forces such as abrasion, tension, vibration, impact and corrosion, against the desired maximum open active screening space per unit of screen area.

"MESH" vs. "OPENING" (or "SPACE")

"A clear distinction must be recognized between 'MESH' and 'OPENING' (or 'SPACE') before an intelligent specification for wire cloth can be written. 'MESH' is measured from center to center of wire—'OPENING' is the space in the clear between wires."



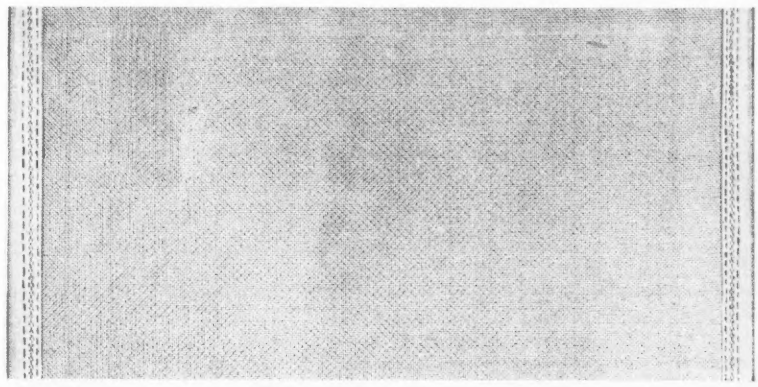
½ inch Opening
No. 4 .225″ Wire.
Opening .500″ Wide

½ inch Mesh (2 Mesh)
No. 4 .225″ Wire.
Opening .275″ Wide

½ inch Opening
No. 11 .120″ Wire.
Opening .500″ Wide

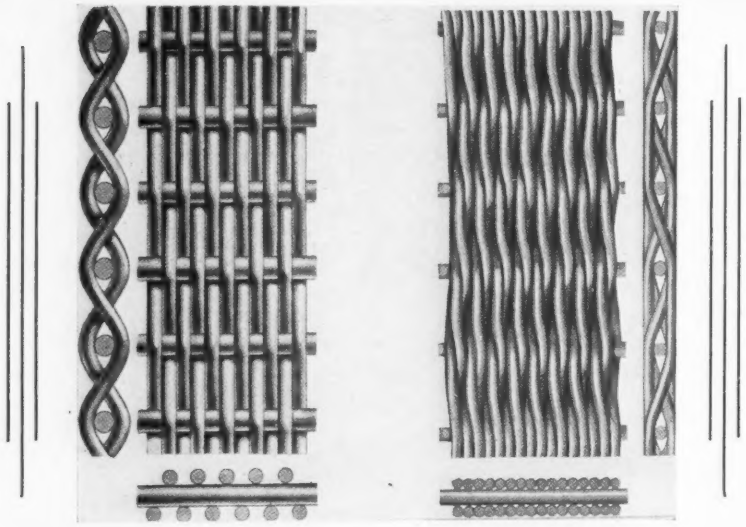
½ inch Mesh (2 Mesh)
No. 11 .120″ Wire.
Opening .380″ Wide

"Be sure to understand clearly the distinction between 1 inch, ¾ inch and ⅝ inch MESH, and 1 inch, ⅞ inch and ¾ inch OPENINGS." ✦ ✦ ✦ ✦ ✦ ✦



Flexible Wire Belting, bound with Cotton Webbing at edges. ✦ ✦ ✦ ✦

MONEL METAL AND NICKEL DUTCH CLOTH
(Corduroy Cloth or Filter Cloth)



Magnified view of Plain Weave.

Magnified view of Twilled Weave.

MANY users turn to oblong openings instead of square openings in an effort to get a combination of heavier wires with larger proportion of active open screening space, and our REKTANG or long mesh screens have proved a most satisfactory solution for the particular application problem.

✦ ✦ ✦

IN contrast with the open area problems involved in screening for fine through products, are the requirements for filtration, where liquids must pass through the screen openings and solids of whatever size must be retained upon the screen.

✦ ✦ ✦

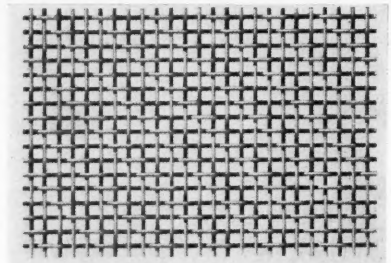
VARIOUS weaves and patterns have been worked out to afford maximum porosity combined with tightness and uniformity of weave; the selection of suitable wires for weaving into such screens has been a matter for long experiment. In the first place the pores or openings are desired as small as possible and this condition limits definitely the wire diameters useable for the purpose. Opposed to this limitation to small diameter wires is the need for mechanical cleaning of filter-cake from the screen at frequent intervals. The cleaning mechanism is frequently harder on the cloth than the filtering process itself, and the problem has been to produce a cloth that will not wear through, stretch or tear under the action of mechanical cake-removers.

✦ ✦ ✦

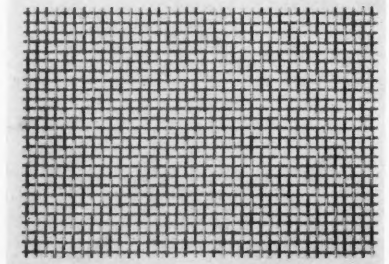
USING maximum wire sizes to produce minimum sized openings in maximum numbers presents a weaving problem requiring wires of most exacting specifications.

Every wire must be absolutely smooth. Every wire must be absolutely round. Every wire must be uniform in size, shape, temper, analysis, tensile strength and workability — and these properties must be found in combination to resistance to the widest possible variety of corrosives.

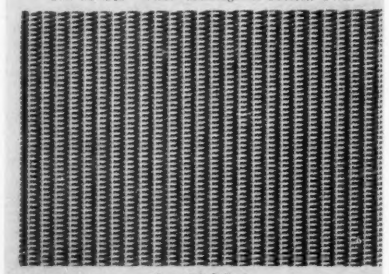
SPECIAL WEAVES



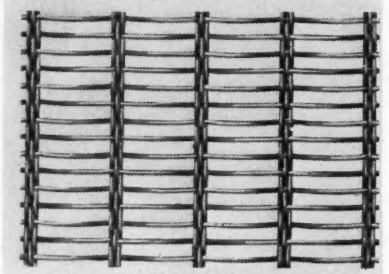
12 Mesh
No. 22 .028" Wire. Twilled Weave



18 Mesh
No. 26 .018" Wire. Herringbone Pattern Twill



12 x 66 Mesh
No. 24 .023" and No. 28 .016" Wire. Dutch Weave



2 x 10 Mesh
No. 20 .035" and No. 22 .028" Wire. Triple Warp

I HAVE given you above the above extremes in meshes and various extreme diameters and wish to add that these could be made in all the various grades of steel, ferrous and non-ferrous metals.

Make Your Plans Now To Attend

THE ANNUAL WIRE ASSOCIATION MEETING AND CONVENTION

To Be Held In Association With The

NATIONAL METAL CONGRESS

At DETROIT, MICH. OCTOBER 17th to 21st, 1938

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· WIRE DRAWING MACHINES ·

For Non-Ferrous Wire in Coils —
Strictly Modern in Every Respect

SIZES AND EQUIPMENT AS SPECIFIED

MOTOR DRIVE: With or without friction clutch control.

WIRE BLOCKS: Plain or stripper type; interchangeable for diameter; provision for rotation in either direction, if desired.

FINISHING DIE HOLDER: Universal adjustment for casting wire; provision for clamping die against movement.

STRINGERS: Hand or power driven.

WATERBURY FARREL FOUNDRY AND MACHINE CO.

WATERBURY, CONNECTICUT, U. S. A.

CLEVELAND CHICAGO NEWARK, N. J.

TUBE DRAWING MANDRELS

The closer tolerances, more rigid specifications and increased use of alloy steels have brought tube makers new problems. Steel mandrels fail to meet the new conditions. Many large manufacturers who are using mandrels made of Firthaloy are having no difficulty in meeting these new specifications and at the same time obtain superior finish on the inside of tubing.

The hard polished surface of Firthaloy mandrels will not pick up or hold the slivers that result in the scratching or marring of the finished work. They hold size over a long period of time giving remarkable "on size" footage, as well as eliminating frequent replacements.

The steadily increasing use of Firthaloy mandrels proves that they are very economical when their ultimate cost is compared with that of other mandrels, and when the long life and better finished tubing obtained is considered.

Firthaloy tube mandrels are available with shanks to fit your holder bars or rods and are furnished in all of the standard and special sizes, including finished and unfinished shells for manufacturers who prefer to make mandrels for their own use.

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NON-FERROUS METALS

Devoted to the art of working non-ferrous metals together with the application of metallurgical and scientific studies to these and related problems and to improve the maunfacturing processes of non-ferrous rod, wire, strip and tubing, electric wire and cable of all types, bare and covered.

Vol. 13 OCTOBER, 1938 No. 10

Chromium Copper Alloy Wire

By C. H. Davis,

Assistant Technical Manager,
The American Brass Co., Waterbury, Conn.

An investigation of the properties of chromium copper alloy wire with particular reference to the qualities of high conductivity, high tensile strength and ability to withstand temperature changes such as would ordinarily occur through the annealing of most bronze wire.

AS in the case of some other heat-hardenable copper alloys, Chromium Copper was known and studied several years before the discovery was made that it might be hardened by a low-temperature heat treatment. Even at the present time there is very little in the literature to indicate the range of physical properties that may be obtained in Chromium Copper by variation in processing. The object of this paper is to outline the present practice and to reveal the manner in which the desired properties may be secured. Although this alloy is not restricted in its uses, and may be obtained in the form of castings, heavy bars, sheets and rods, it also is used in the form of wire and thus is considered a suitable subject for presentation to this Association.

✦ ✦ ✦

G. **HINDRICHS**[1] in 1908 published the first work on the Chromium Copper equilibrium diagram. It was not until 1923 that another comprehensive study was made of the diagram, this time by **Siedschlag**[2]. We are not now particularly concerned with the entire diagram but rather with the copper-rich end comprising up to 1% chromium. The only published data to date on this part of the system are those of **Corson** in 1927[3] and 1930[4].

Acknowledgment is made of the permission of The American Brass Company to publish this portion of the Chromium Copper investigation and to Dr. Cyril Stanley Smith and Mr. Phillip H. Kirby for their valuable assistance.

C. H. DAVIS

Yale, A.B. 1909, Stanford University, M.A. (Geology) 1912. Employed continuously since 1912 by The American Brass Company, Waterbury, Conn. During the period 1919-1938 in charge of their Chemical and Metallurgical Laboratory. Present position, Assistant Technical Manager.

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IN the meantime, **Hunter** and **Sebast**[5] investigated the Chromium Copper alloys and produced them in wire form containing as much as 17% chromium. Those alloys containing from 0.5 to 1% chromium were found to have conductivities of from 47 to 54% and to have a tensile strength of the order of 45,000 pounds per square inch. **Hunter** and **Sebast** did not investigate the heat-hardening effects apparently because they believed the two metals were insoluble in each other. It was said that the chromium existed in fine particles in a matrix of copper.

✦ ✦ ✦

IN 1924, **Michael G. Corson** made patent application for Chromium Copper as an alloy for electrical conductors. The U. S. Patent No. 1,723.867 did not issue until August 6, 1929. **Corson's** preferred alloy[6] contains 0.5 to 3% chromium with the balance sub-

stantially copper. The patent explains the process of hardening such an alloy by heating in the temperature range 400° to 700°C. following which it might be subjected to cold working. He states that a conductivity of 80% M.S., coupled with a tensile strength of 72,000 to 80,000 pounds per square inch, can be obtained. Corson recommends that the copper be first deoxidized with silicon or phosphorus in amount, for instance, about 0.2%. Normally such deoxidizers greatly reduce the conductivity of pure copper. When chromium is added, however, the effect of such deoxidizers in reducing conductivity is much lessened.

✦ ✦ ✦

IN other studies of precipitation-hardening copper alloys, **Corson** discovered chromium as well as cobalt and nickel formed an effective hardening agent as chromium silicide (Cr_3Si). This point is embodied in his U. S. Patent No. 1,658,186, application for which was filed September 25, 1925.

✦ ✦ ✦

CORSON'S British Patent No. 268,200, granted in 1927, includes the method of preparing a Chromium Copper containing 0.2 to 3% chromium by quenching from between 700°C. and the melting point of the alloy, thereafter subjecting it to mechanical working. Non-annealing is pointed out as the desirable property of this alloy. The values shown in Table A are offered.

✦ ✦ ✦

CORSON presented further information in a series of articles in **"Revue de Metallurgie"**[4], a synopsis of which had previously appeared in 1927[3]. For Chromium Copper the range of solid solubility given is 0.8% at 100°C., 0.5% at 900°C., 0.25% at 800°C., 0.05 to 0.1% at 500°C. The above citations tend to show that Corson first demonstrated the processes by which the Chromium Copper alloys containing nominally from 0.5 to 1% chromium could be treated so as to obtain high physical strength and high conductivity. Other British and American patents have been issued since these of **Corson** but they have dealt principally with the addition to the Chromium Copper of a third, or third and fourth elements. These include: aluminum, beryllium, cadmium, cobalt, nickel, silver, thorium, tin, zinc, zirconium. Various advantages have been claimed for such additions not only in improving the casting and manufacturing properties but those qualities that may have special applications in service.

TABLE A

	Tested Cold	Tested at Temperature of 400° C.
Tensile Strength, PSI	52,000	40,000
Elongation in 2", %	25	20
Brinell Hardness	100	

TABLE B

	Tensile Strength	Elongation in 10"	Conductivity I. A. C. S. at
	PSI	%	20° C.
Maximum	72,500	3.75	88.0
Minimum	61,800	1.33	66.0
Average	66,180	2.78	82.0

✦ ✦ ✦

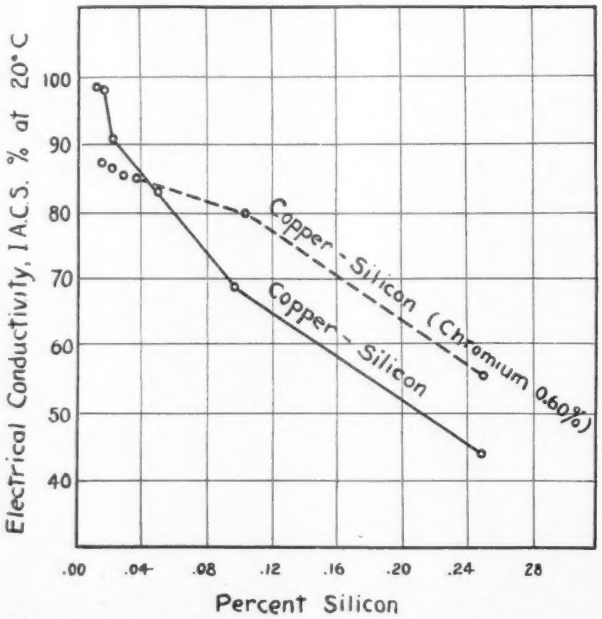

Fig. 1—Chromium Copper wire, containing silicon, 0.080" dia. drawn from quenched and precipitation-hardened rod at 0.44" dia. This is to be compared with the binary copper-silicon alloy. Chromium lessens the effect of silicon on conductivity. ✦ ✦ ✦ ✦ ✦

THE study of the more commercial aspects of the Chromium Copper alloys was begun about 1924. The progress was rather slow at first because of the range of possibilities to be investigated. Much more impetus has been developed in the last five years, particularly in the electrical and the welding industries. One of the difficulties encountered in the earlier work was the problem of adding the chromium so as to avoid great losses. Such losses have ranged from 10 to almost 40% but in recent practice, have been confined to from 10 to 30%. The patent literature recommends several ways of introducing chromium into the copper and variations of these methods are actually being used in industry.

✦ ✦ ✦

THE results of the early work (1924) by **The American Brass Company** revealed that the best combination of strength and conductivity was secured at about 1% chromium, some silicon, balance copper. A number of elements were added to the Chromium Copper with the intent of increasing the tensile strength but in those cases it was found that the physical properties and conductivity obtained were not better than could be secured in the cadmium copper alloys.

REPRESENTATIVE values secured on ⅜" diameter wire, approximately 8 B & S numbers hard, were as shown in Table B.

✦ ✦ ✦

TO show that the chromium actually lessens the depressing effect of silicon on the conductivity of copper, Fig. 1 has been prepared. The effect of additions of other elements is found in the literature in two cases, that of silver by **P. H. Brace**[6], that of Beryllium by **Harrington**[7], and **Fuller**[8].

✦ ✦ ✦

CHROMIUM Copper as commercially produced required further study to obtain data on ranges to be expected in conductivity and physical properties. Some of the results of these efforts are now presented.

✦ ✦ ✦

HOMOGENIZING temperatures of 900, 950, 1000 and 1025°C., followed by quenching, were employed. Variations in the precipitation-hardening treatment ranged from 400°C. to 600°C., all for a uniform period of three hours. The portion of the work on wire covered reductions by cold drawing up to 10 B & S numbers. A study was made of the effect of various lengths of time on the precipitation hardening. For instance, samples of homogenized and quenched rods were annealed at 450°C., 500°C., and 550°C. for various lengths of time for fifteen minutes to twenty hours. These data are not included in this paper for they simply reveal that complete precipitation can be secured in three hours or less.

✦ ✦ ✦

A SELECTION has been made from several tables of tension tests to show the effect of certain combinations of annealing, cold drawing, and precipitation-hardening treatments. (See Tables C, D, E and F). The rods had the composition

Copper	**98.80%**
Chromium	**0.89**
Silicon	**0.09**
Iron	**0.07**

✦ ✦ ✦

THE precipitation-hardening treatment may be applied to annealed and quenched material, or to hard drawn rods or wire, thus

TABLE C

Rods ½" diam. Annealed ½ hr. at 1025° C. Quenched, then hardened by 3-hr. treatment at temperatures given

Annealing Treatment	Hardness		Yield Strength PSI		Tensile Strength	Elong. in 2"
	Brinell	Rockwell				
3 hr. at	500 Kg	"B"	0.50%	0.75%	PSI	%
	42.9	-33.				
400	73.6	39.2	28,500	30,400	58,100	25.0
450	115.	70.1	53,900	55,300	80,300	20.0
475	115.	72.0	56,600	57,800	76,000	18.0
500	119.	71.0	56,400	57,500	72,300	20.0
525	109.	64.4	49,600	50,900	66,900	25.5
550	92.6	50.5	36,700	38,000	57,300	34.0
600	78.4	35.2	29,600	30,900	50,900	32.0

TABLE D

Rods ½" diam. Annealed ½ hr. at 1000° C. Quenched, then hardened by treatment at 500° C. for length of time given

Time	Hardness		Yield Strength PSI		Tensile Strength	Elong. in 2"
	Brinell	Rockwell				
Hrs.	500 Kg.	"B"	0.50%	0.75%	PSI	%
¼	97.1	57.7	36,000	37,200	70,100	27.0
½	111.	66.1	45,200	46,600	73,800	23.5
1	113.	66.2	47,900	49,000	68,200	21.0
2	120.	69.1	50,600	51,600	67,200	19.0
3	129.	73.9	56,300	57,400	72,300	22.0
4	119.	72.3	49,900	51,500	62,400	13.0
8	120.	68.4	52,800	54,700	69,300	21.5
16	112.	64.8	35,900	36,700	45,600	24.0

TABLE E

Rods ½" diam. Annealed ½ hr. at 1000° C. Quenched, drawn 4 B & S nos. hard then hardened by 3-hr. treatment at temperatures given

Annealing Temp. °C.	Hardness Rockwell	Yield Strength PSI		Tensile Strength	Elongation in 2"
3 hours	"B"	0.50%	0.75%	PSI	%
None	67.5	59,100	61,400	61,700	10.5
350	70.9	58,400	59,700	63,100	12.5
400	76.9	70,800	72,000	74,300	14.0
425	78.9	60,500	68,500	80,000	14.0
450	82.4	65,400	67,300	73,000	17.0
475	79.4	69,400	71,400	77,200	14.5
500	77.3	67,300	68,500	75,000	15.0
525	74.1	60,700	62,100	70,500	17.0
550	68.1	51,600	53,000	62,500	18.0
600	51.4	33,800	35,300	47,500	26.0

TABLE F

Rods ½" diam. Annealed ½ hr. at 1000° C. Quenched, hardened by 3-hr. treatment at 500° C., then cold drawn from 1 to 10 B & S nos. hard.

Reduction After Anneal	Rockwell Hardness	Yield Strength PSI		Tensile Strength	Elongation in 2"
B & S No.	"B"	0.50%	0.75%	PSI	%
None	70.5	55,900	57,100	71,300	21.5
1	78.4	82,100	84,200	84,300	7.0
2	77.2	80,800	84,600	85,000	8.0
4	76.1	81,200	84,600	85,400	9.0
5	78.8	76,800	83,900	85,200	6.5
7	83.3	86,600	87,600	87,600	6.0
10	84.8	81,600	89,200	90,600	3.5

securing an increase in the hardness, strength, and conductivity. The physical characteristics of the alloy are such that the precipitation-hardened material may be further cold worked or drawn so as to obtain a greater increase in strength with no loss in conductivity. Fig. 2 illustrated the effect of the precipitation-hardening treatment on three groups of rods homogenized at 900°C. and 1000°C., and quenched. Two were then drawn 10 B & S numbers hard. For comparison, one rod is shown precipitation-hardened without the final draft. It is seen that the rods hard drawn following precipitation hardening have a higher conductivity than the rods not drawn.

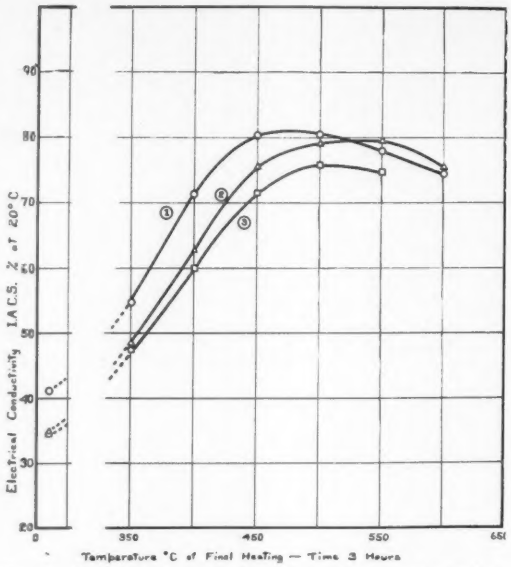

Fig. 2. Rods ½" dia. annealed (homogenized) and quenched, then hardened by low-temperature treatment. Curve #1, rod quenched from 900°C. then drawn 10 B & S nos. before hardening. Curve #2, rod quenched from 1000°C. then drawn 10 B & S nos. before hardening. Curve #3 rod quenched from 1000°C. then hardened without any intermediate cold work.

✦ ✦ ✦

FIG 3. illustrates clearly that a greater strength can be secured by precipitation hardening on material that has been previously homogenized at the highest possible temperatures, for instance 1000 to 1025C. It is difficult in mill practice to secure rapid quenching from such high temperatures, therefore commercial rods will in most instances have the lesser qualities that are indicated by the lower homogenizing anneals, for instance 950°C.

✦ ✦ ✦

FIG. 4 indicates the range of physical properties that may be expected in hard drawn rods or wire The effect

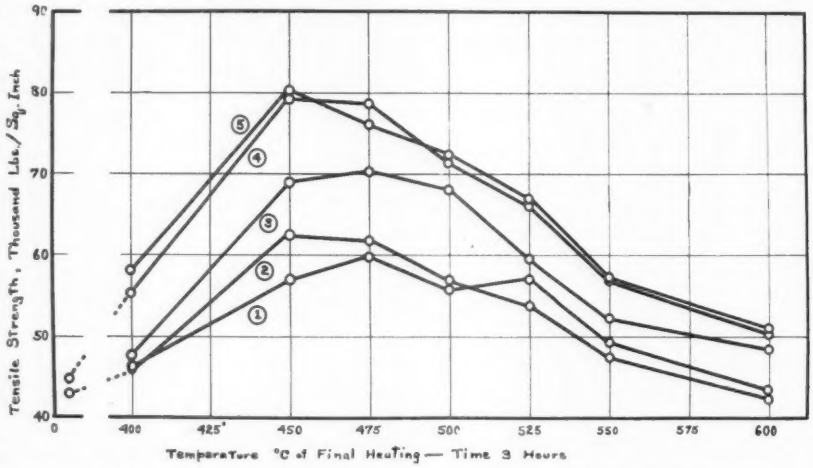

Fig. 3. Rods ½" dia. annealed, quenched, then reheated at temperatures 400° to 600°C.

Curve #1 Quenched after 2 hrs. at 900°C. then reheated
Curve #2 Quenched after ½ hr. at 900°C. then reheated
Curve #3 Quenched after ½ hr. at 950°C. then reheated
Curve #4 Quenched after ½ hr. at 1000°C. then reheated
Curve #5 Quenched after ½ hr. at 1025°C. then reheated

TABLE G

	Rockwell Hardness "B"	Yield Point 0.50% PSI	Tensile Strength PSI	Elongation in 2" %	Conductivity I. A. C. S. at 20°C. %
Soft	Minus 30	14,000	45,000	40	35
Soft, then heat-hardened by treatment of 3 hr. at 500°C.	70	55,000	70,000	21	75
Cold drawn 4 B & S wire nos.	65	56,000	57,000	11	35
Cold drawn, then heat-hardened by treatment of 3 hr. at 450°C.	82	65,000	77,000	16	72-75

of the cold work is independent of the homogenizing temperature. It is noteworthy that most of the increase in hardness and yield strength develops with moderate reductions; also that cold work increases the yield strength to a value only slightly less than that of the tensile strength itself.

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THE influence of cold work on material that has already been hardened by heating, varies with the amount of precipitation hardening that has occurred, Fig. 5.

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THREE factors affect the final physical properties of Chromium Copper; namely, the homogenizing treatment, the amount of cold working and the precipitation-hardening treatment. Homogenizing is preferably done for a period of one-half hour at 1000°C. followed by a rapid quench. If these conditions are not adhered to the physical properties that can be obtained by the subsequent heat treatment are greatly lessened. The amount of cold working may vary from none to a reduction of possibly 10 B & S wire numbers. If articles are to be formed or processed into devices of various shapes, it will be important to have the Chromium Copper furnace in an annealed or homogenized con-

dition. After the forming or fabricating has been accomplished, the final precipitation-hardening treatment may be given. In rod or wire, however, it is likely that great strength will be desired, consequently the material should be furnished hard drawn following the precipitation-hardening treatment. The third factor, the hardening anneal or heat treatment, may be given to the homogenized Chromium Copper or to cold worked material. For the former, namely in the soft condition, a three-hour treatment at 500°C. will develop maximum hardness and yield strength. Maximum tensile strength is developed at 450°C. For material cold drawn 20% or more, the maximum values of yield strength and hardness as well as tensile strength are developed by a three-hour anneal at 450°C.

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THE same procedure for homogenizing and for precipitation-hardening that develops maximum strength also develops practically the maximum electrical conductivity.

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TABLE G gives conservative representative values for commercial material heat treated with and without cold work. The rods were homogenized one-half hour at 1000°C. and quenched:

✦ ✦ ✦

SOME of the uses to which Chromium Copper may be put include:

Electrical Conductors and contactors.
Circuit breaker parts.
Commutator segments
Pole line hardware.
Terminals and studs.
Bolts, nuts, clamps.
Wire and cable connectors.
Spring devices for moderately high operating temperatures.
Welding electrodes, tips, dies, wheels, etc.
Devices where high conductivity, high strength and resistance to softening are requisites.

✦ ✦ ✦

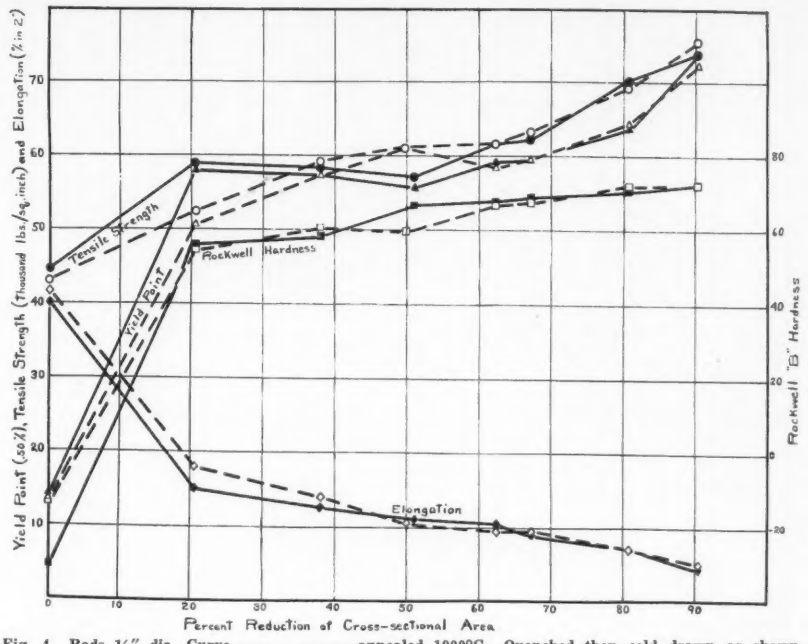
Yield Point (.5%), Tensile Strength (Thousand lbs./sq. inch) and Elongation (% in 2")
Rockwell "B" Hardness
Tensile Strength
Rockwell Hardness
Yield Point
Elongation
Percent Reduction of Cross-sectional Area

Fig. 4. Rods ½" dia. Curve ——— ——— annealed 1000°C. Quenched then cold drawn as shown. Curve ——— annealed 900°C. quenched then cold drawn. Note high yield strength after moderate reduction.

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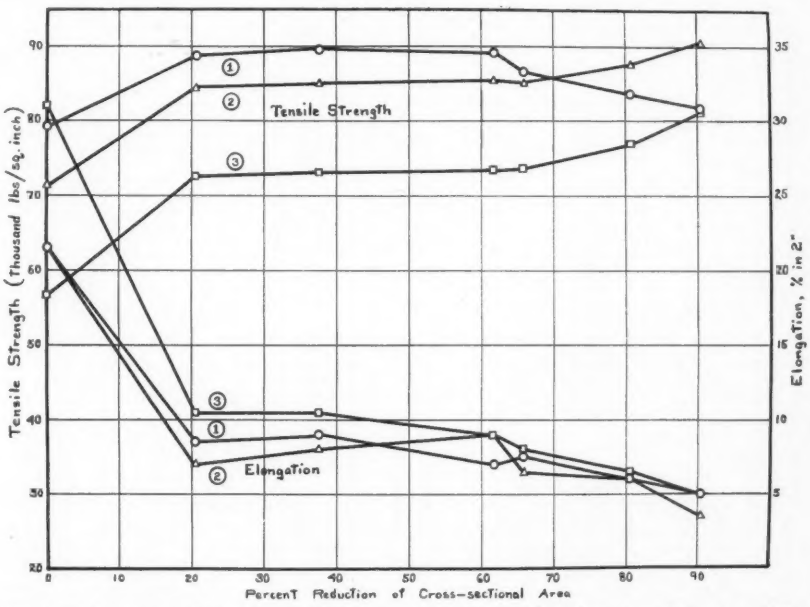

Fig. 5. Rods ½" dia. All first homogenized ½ hr. at 1000°C. quenched, then given different precipitation-hardening treatments, i.e. at 450°C. Curve #1; at 500°C. Curve #2; and at 550°C. Curve #3. Finally the three lots of rods were cold drawn with reductions shown.

✦ ✦

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AND SYNCRO MACHINE CO.

ESTABLISHMENT of a definite wire division of the Elevator Supplies Co., Inc., became effective on Sept. 14th, 1938 through the amalgamation of interests with the Syncro Machine Co. of Newark, N. J.

+ + +

WITH this change, all activities of the Elevator Supplies Co., Inc., in Sales, Service, Engineering and Development throughout the entire wire and wire products industry will be carried on by the

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which will become the wire division of this old and well established company.

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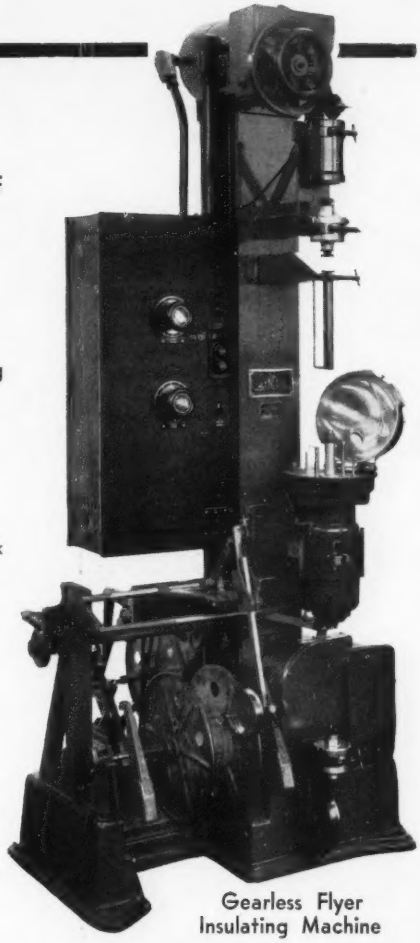
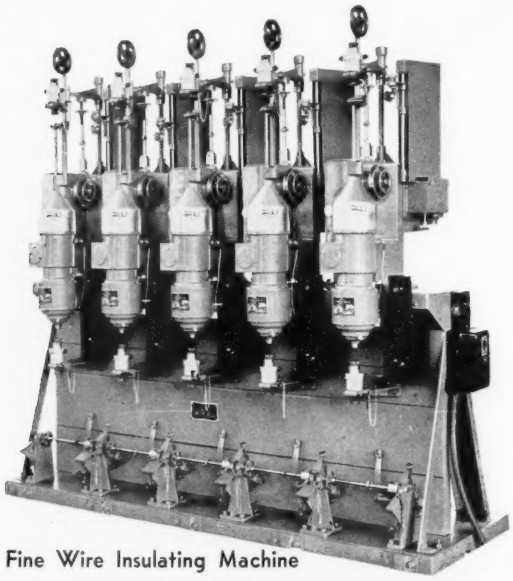
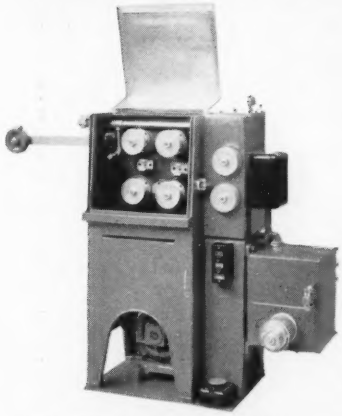


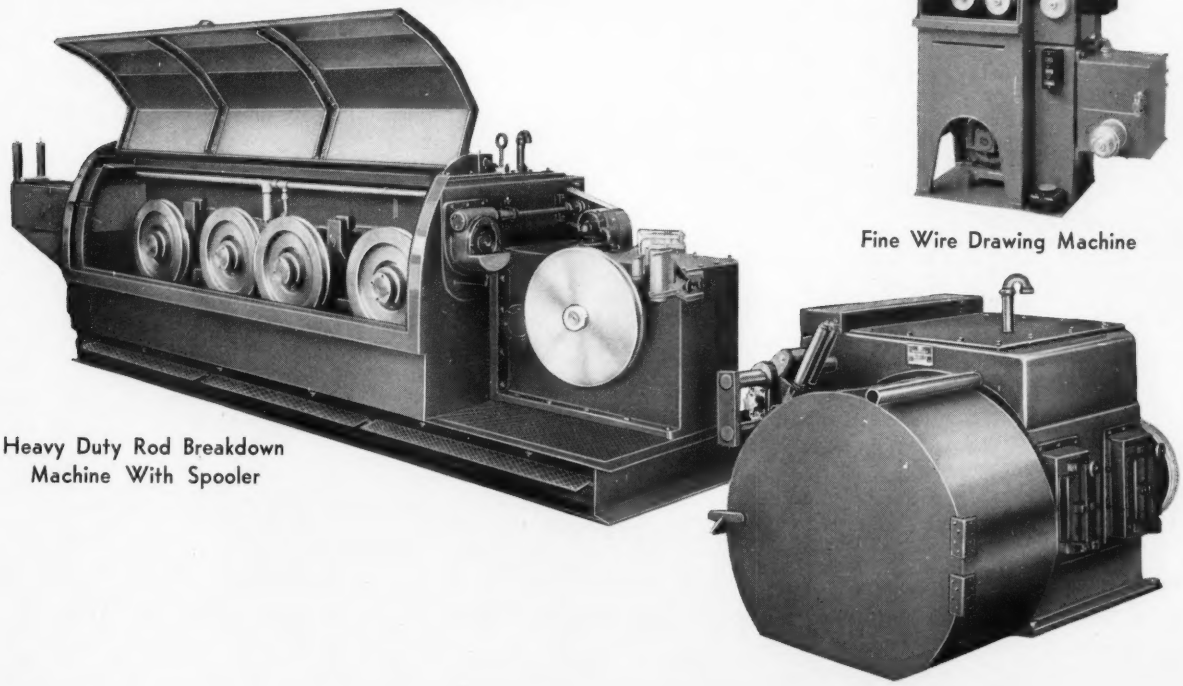
Gearless Flyer Insulating Machine



Fine Wire Insulating Machine



Fine Wire Drawing Machine



Heavy Duty Rod Breakdown Machine With Spooler

Heating Copper Wire Bars

By J. A. Doyle,
Vice President,
W. S. Rockwell Co., New York, N. Y.

This paper is constructively critical of refinery practice and methods of heating for rolling, in the belief that such comments are in order for the good of the industry. It is part of the purpose of the paper to invite comment and discussion in the hope of compelling recognition of the need for improvement in methods of heating in the refinery and in the rolling mill because of their influence on the ultimate product. ✦ ✦

CONSUMER demand for more uniform copper wire of better quality has developed thought of possible influence of the several heating processes on metallurgical structure, their effect on fabrication, and, ultimately, on the sale and useful service of the finished product.

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AMPLE evidence is available, accumulated in actual practice, to establish the fact that the heating processes have a pronounced influence on both quality and cost; in the refinery, in heating for rolling, and the annealing operations incident to the drawing process, particularly with the high speed mechanism that, apparently, indicates the practice of the immediate future.

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Influence of Heating Methods

INFLUENCE of heating methods is first made apparent by reverberatory practice in the refinery which, judged by established heating practice in other operations, is of relatively low standard. The method of melting and equipment is, in principle, today substantially as it has been during the modern life of the industry. The method of firing and charging, and the process of eliminating impurities, some of which are due to relatively crude heating practice, are not up to the standard established in other operations by an effort to avoid the inherent defects and difficulties incident to the practice of heating large quantities of metal, intermittently, by the batch process.

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IT is apparent that there is substantial room for improvement in refinery melting practice which, however, is retarded by the drag of tradition and the more or less natural inclination to resist change until it is forced by customer demand, or competitive effort. The change in method of rolling steel sheets, forced by demand of the automobile manufacturers for more uniform product, may indicate the process by which heating practice may be improved in the refinery where, believe it or not, metallurgical uniformity is adversely affected by methods of heating. An added incentive to study possibility of improvement lies in the apparent latitude for decreased cost of production by improved methods that will make possible better control of uniform quality.

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ROLLING mill operations are doubtless affected by variations in refinery heating practice which, in turn, is often held responsible for additional defects that are really due to improper methods of heating for rolling, or the several annealing operations forming part of the drawing process.

Heating for Rolling A Source of Difficulty

HEATING for rolling is a prolific source of difficulty and controversy between the refinery, the rolling mill, and the wire plant. It is not anywhere near the standard established for annealing and, as with time-worn reverberatory practice, must be improved to meet the demand for better quality, faster rolling and drawing, and lower cost of the finished product. The refinery, all too frequently, assumes responsibility for conditions that are really due to improper practice of heating for rolling that have been established and are illogically maintained by the wire mills. An impartial survey of prevalent methods of heating for rolling sustains this point of view.

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IT is the rule rather than the exception to heat wire bars altogether too fast, and not uniformly as to temperature or atmosphere, in a furnace that, in effect, is little more than a brick-lined blow torch. Even though we start with the assumption—false though it may be—that the metallurgical ancestry of the wire bar is beyond reproach, it is apparent that such heating practice may logically be considered responsible for defects in the wire that, frequently, are illogically assumed to be due to the wire bar itself.

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Factors Responsible for Defects

FACTORS responsible for such defects may properly be assumed to include unreasonable temperature head; lack of uniformity in applying heat to the bar; unwarranted emphasis on tempera-

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ture control as indicated by the pyrometer without thought of possible inequality of temperature throughout the bar; undesirable atmosphere or lack of uniformity of desirable atmosphere; oxidation incident to defective combustion or infiltration of air; contamination of the bar by contact with skid rails, scale, or otherwise; variations in firing due to inattention, or lack of skill of the operator, variation in oil pressure or air flow, dirt laden oil, etc.

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IT is evident that there is much room for improvement in methods and equipment commonly used for the important process of heating for rolling that exerts substantial influence on subsequent fabricating and annealing operations.

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COMMON practice in heating standard 250 to 300 lb. wire bars, under such conditions, is to maintain a heating period of from 40 to 45 minutes, which is really too fast for a bar approximately 4 in. square. Such rate of heating is possible because of an unwarranted high temperature head which may vary from 300° F. to 600° F., resulting in a furnace temperature of from 1950° F. to 2200-2300° F.

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Excessive Temperature Head

EXCESSIVE temperature head frequently causes bars to stick together and discharge two or more at a time, which may not be detrimental but is sometimes inconvenient. At times the temperature head is so great that a slight mill delay will cause the bars to melt with consequent damage to the furnace in addition to the loss in metal. Usually, when there is such a mill delay, the operator will continue to discharge the bars, to avoid sticking or melting, and stack them on the floor to cool before they are again charged. This method not only decreases the fuel efficiency but may actually cause damage to the furnace. The damage may be due to scale, which drops off as the bar is re-heated and is deposited on the skid rails, rail supports, and the furnace hearth. The scale may build up to such an extent that the bars will ride on the scale instead of skid rails. When this happens the bars are likely to be scored and pick up scale which is actually rolled into the wire.

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ANOTHER defect of the high temperature head practice is the tendency to overheat the outside of the bar, and the tapered ends, and under heat the inside. This is responsible for some rolling problems and uneven metal structure. Excessive temperature head is further objectionable because it increases the cost of furnace maintenance, particularly if air is drawn through the furnace during a shut down period with consequent cracking and spalling of the refractory lining; also because the induced air oxidizes the bars in the furnace.

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Trend Toward Lower Temperature Head

DECIDED trend toward lower temperature head, and longer time for saturation, with consequent increase in heating area, is a result of recognition of the detrimental effect of the heating practice above referred to. Heating time has been increased from 40-45 min. to 60-80 min., in furnaces recently installed, the operation of which justifies the change.

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LONGER heating time naturally increases the length of the furnace, or effective heating area, and cost of installation. When the desired conditions of temperature and time involve an unusually long furnace, it is permissible to heat the bars in two rows instead of one, which has the effect of decreasing the length and increasing the width of the heating chamber. This is at times questioned in the belief that the heat distribution is likely to be unfavorable but, in practice, it has been found quite effective in furnaces with a chamber about 12 ft. wide with no apparently objectionable temperature differential across the chamber or throughout the length of the individual bar.

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Favorable Temperature Distribution

FAVORABLE temperature distribution in such an unusually wide chamber is the product of good furnace design, proper combustion chambers and burner placement, location of vents, positive control of all the air entering the furnace, maintenance of slight outward pressure, and automatic temperature control. An essential feature of good design is provision for the discharge position on a higher plane than the charging level. This tends to form a heat seal at the discharge end and to prevent infiltration of cold air, thus decreasing appreciably the scaling action and tendency to cool the bars when the door is opened. It also provides more favorable temperature reading, and a somewhat lower temperature head, as the thermocouple at the discharge end is less affected when a bar is discharged.

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Decrease in Scale

DECREASE in amount of scale is quite noticeable in comparison with that produced by the older furnaces having horizontal hearths, inadequate combustion chambers, and connected to high stacks which serve to induce cold air, particularly those in which a high temperature head is maintained. Some such furnaces are in operation without provision for dampers which, when available, are rarely adjusted. This represents a decidedly unfavorable condition and clearly indicates possibility of contaminating the bars in the heating operation.

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HEAVY scale produced by either of the conditions above referred to is objectionable because it is not readily released by the water jet at the first pass; also because it represents a loss of metal. On the other hand, if the atmosphere is too reducing, too little scale of the wrong kind is likely to be formed. Such scale is primarily

cuprous oxide with probably some copper dust and is noted for its tenacity in the rolling process. The red scale is not so readily formed in a properly designed and operated oil furnace, but it may be quite a problem with gas under unfavorable conditions.

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RECENT designs of wire bar furnaces provide for burners in the side walls as well as in the end wall. This change in number and position of burners involves two zone control which, though more expensive, tends to provide a better control of the heating operation.

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Automatic Temperature Control

AUTOMATIC temperature control should be considered with certain reservations in relation to oil fired furnaces which do not provide the accurate temperature control to which we are accustomed with gas fired and electrically heated furnaces. This is not due to lack of proper control mechanism, or to the nature of the oil as such. It is actually due to contamination of the oil with dirt or other foreign matter which eventually reaches the control valves, even though filters are placed in the line. Since the orifices in the regulating valves are relatively small, such contamination tends to build up, decreasing the valve area, and slow down the oil flow to an extent that one burner may operate with a shorter flame than another. As a result, one section of the chamber may heat at a different rate than another. The condition is objectionable because it does not affect the thermocouple continuously, with the result that a chart may be produced indicating a desirable uniform temperature which, in fact, may not truly represent the temperature throughout the chamber.

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Contamination of Oil

CONTAMINATION of oil may occur at the oil refinery or in storage prior to delivery. It may represent accumulation formed in storage tanks connected to the furnaces. Unless the oil is delivered reasonably clean, sludge will accumulate in the storage tanks and, ultimately, foul the pipe lines and valves. It is not uncommon to discover that the oil is pumped from the sludge section of the storage tank, even though the oil on top of it is relatively free from foreign matter; and that there is no provision for straining.

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CLEAN oil at uniform pressure is desirable for good heating. The fact that accurate temperature control is provided with continuous oil fired automatic furnaces provided with automatic temperature control, and that domestic oil burners may function favorably with automatic temperature control, clearly indicates the possibility of removing one cause of the difficulty in wire bar heating practice by providing for uniform delivery of relatively clean oil to the furnace.

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WITH all its faults, automatic temperature control for oil furnaces is better than manual control because it is on the job continuously while the furnace is operating. But, it cannot entirely dispense with a good operator, or "heater" who, necessarily, is required to exercise judgment when confronted by conditions beyond the furnace that require variation in the heating process.

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Temperature of the Bar

TEMPERATURE of the bar is more of a controlling factor than the temperature of a section of the chamber indicated by the pyrometer, which is about all that is available with the usual type of resistance pyrometer. The need for the more accurate determination of the temperature of the bar invites consideration of the radiation type pyrometer which permits indication of the temperature of the bar, or of the furnace, as required. An oil furnace frequently develops certain problems when operated with the radiation type instrument such as occasional smoke which may obscure the visual range of the pyrometer, or occasional flames that move over the tops of the bars and may react in momentary high temperature reading.

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RECORDING temperature of the bar, just before it is discharged, without having the reading influenced by the discharge door radiation, is another advantage made possible by the radiation type instrument. However, it should be assumed that the pyrometer reflects the temperature of the bar at one point and as the bar may be about 54 in. long it is essential that the chamber temperature be uniform. The difficulty of indicating temperature throughout the length of the bar is another reason why it is essential that the furnace design be the best possible; and in charge of an intelligent operator competent to do what is required when there is a momentary break in the long chain of variable factors controlling the operation as a whole.

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A RECENT installation of a furnace designed for an output of 50,000 lbs. per hour is oil fired and arranged to accommodate two rows of bars. Three radiation pyrometers are used with gratifying results. Two of the instruments control the furnace temperature while the third functions as a safety shut off. The temperature of the bars, which reflects uniformity of temperature throughout the chamber, is quite favorable.

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Improved Heating

IMPROVED heating is made possible by raising the bars a substantial distance from the floor of the furnace and suitable location of vents. The distance is sufficient to form flues to carry a substantial volume of hot gases to the outlet flues at the charging end located below the bars. This serves to preheat the metal with heat in the spent gases and, in effect, is a process of recuperating without recuperators. The hot gases under the bars also serve to prevent infiltration of air and decrease scaling. The space beneath the bars, in addition to serving as flues, is sufficient to provide for accumulation of any scale that may be released in the heating process.

Alloy Skid Bars

ALLOY skid bars have been considered from many angles for many years as a substitute for water cooled pipes because of the possibility of saving fuel. Different alloys in many different designs, both cast and rolled, have been tried with different forms of support under different conditions of operation. The result has not been favorable, by and large, and the present trend is to retain the water cooled pipes with better methods of support to provide better application and utilization of heat.

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IN practice, it has been found that alloy metal skids tend to score the bars; also, to contaminate the bars which take up metal from the skids as they are moved. In most cases the objections were sufficient to justify replacement of the alloy skids with the water cooled pipes on the assumption that the actual saving in fuel did not justify the increased first cost of the alloy and the difficulties encountered in the use of it. Future development in alloy metals may warrant a change in practice but, at present, experience has been unfavorable.

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Cold Spots on Wire Bars

COLD spots on the wire bars due to contact with water cooled pipes have been referred to as objectionable but, in practice, it is not vital as the relatively small cold area is wiped out before the bar enters the first pass.

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Lower Fuel Cost

LOWER fuel cost should be considered a possibility in the program for improving the practice of heating for rolling. There is much room for improvement, especially with oil. However, it should be borne in mind that much of the present objection to oil is, in fact, based upon obviously improper methods of application to furnaces of relatively poor design. Furthermore, there is the limitation, even with better furnaces, incident to contamination of the oil with foreign matter previously referred to. The tendency to buy oil mainly on price, and to disregard the need for delivering it to the furnace uniformly in relatively clean condition, handicaps effort for improvement.

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THE undesirable combination, frequently found in service, of a "blow torch" type of furnace, heavy oil thoroughly contaminated with foreign matter, one or more burners blasting through a large uncovered hole, strong unregulated stack pull acting to carry off heat and induce air to the chamber, with little or no control of temperature or atmosphere, inability to apply heat to the bottom of the bars, and an ignorant operator, makes it apparent that there are many factors affecting the rolling operation that are likely to be disclosed in the drawing process. The pity of it all is the high cost incident to a process of saving at the spigot and wasting at the bung.

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Control of Temperature and Atmosphere

CONTROL of temperature and atmosphere is impractical unless there is control of all the fuel and all the air-entering the furnace. This fundamental point, common to the operation of the common coal fired stove or automobile, seems to be considered more in the breach than in the observance in rolling mill practice. It is an illogical as it is wasteful in improper heating of the bars, waste of fuel, high maintenance cost and oxidation of metal.

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BETTER control of temperature and atmosphere may be effected by passing all of the air required for combustion through the burners with provision to completely stop the in flow of air when the fires are shut off. It means a larger blower but this is offset by the saving in scale, fuel and maintenance. Recent furnaces are so controlled with the added provision of maintaining a pressure within the chamber instead of undesirable stack draft.

OIL has been, and still is, with few exceptions, the fuel generally used for wire bar furnaces, but in most cases it is not used as efficiently as it should be. Gas is entering the picture due to substantial reduction in price in recent years, and, further, because of the ease of control of temperature and atmosphere, cleanliness, independence of stack draft, and decreased furnace maintenance. Gas may be somewhat more expensive than oil on a fuel basis for some time to come; but it should be realized that fuel cost is but a part of the actual heating cost which, under certain conditions, may be favorable to gas, all things considered.

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Current Practice

CURRENT practice indicates a fuel consumption of 4 to 6 gals. per ton on a two shift day of a three to four day week operation. This figure is not exceptional but it indicates reasonable operating conditions which are likely to be better on full time schedule.

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FUEL cost is inconclusive when determined on the basis of amount of fuel per ton of output, unless the quality of the bar is considered. Fuel economy on the basis of tonnage resulting from rapid heating is questionable economy. It is the cost per ton of quality metal that really counts.

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Conclusion

IT is reasonable to conclude that quality of copper wire is materially affected by the method of heating in refining, heating for rolling and annealing; also, that standards of heating practice are far below those established for fabrication, even though the heating operations have greater influence on uniformity and metallurgical structure.

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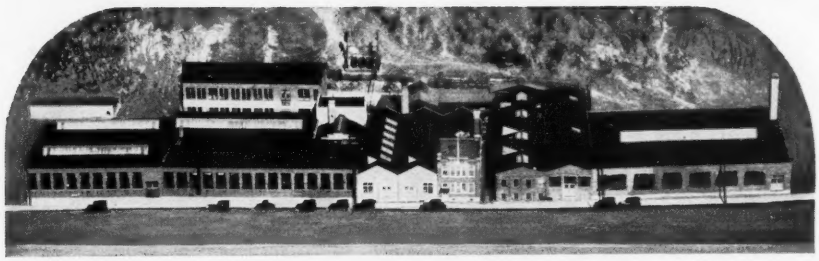
NEED for improvement is apparent and inviting because of the opportunity to establish higher standards for quality and uniformity; also, the possibility of faster rolling and drawing with more uniform metal. An added incentive is the lower cost of production made possible by more rapid fabrication, and that which automatically accompanies better methods of heating to avoid the conditions referred to which are responsible for much of the present day difficulty in production of copper wire.



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Dr. Colin G. Fink,

Head,
Division of Electrochemistry,
Columbia University,
New York, N. Y.

BORN in New Jersey, December 31, 1881. Graduating from Columbia College in 1903, Dr. Fink spent four years in the Ostwald Research Laboratories of the University of Leipzig, receiving his degree of Doctor of Philosophy "summa cum laude superato" in 1907. Returning to America, Dr. Fink joined the research staff of the General Electric Company at Schenectady. He is the originator of the ductile tungsten lamp filament used all over the world. He is also the inventor of the copper-clad nickel steel leading-in wire used as a substitute for platinum in lamps, radio tubes, etc. In 1917 he became the head of the new research laboratories of the Chile Exploration Company, New York. He invented the insoluble anode, "chilex", in operation at the great plant at Chuquicamata since 1922. In 1922 Dr. Fink was called to Columbia University and has since then been in charge of the Division of Electrochemistry. At Columbia he has devoted most of his attention to researches in the electrodeposition of chromium, tungsten, rhenium, rhodium and other metals; the restoration of ancient bronzes; the corrosion of metals and alloys; aluminum plate; electro-tin plate; photovoltaic cells.

✦ ✦ ✦

THE entire chromium plating industry throughout the world is built up on Dr. Fink's basic inventions, covered by U. S. Patents No. 1,581,188, April 20, 1926, and No. 1,802,463, April 28, 1931, bright plate.

✦ ✦ ✦

DR. Fink has perfected a method of tungsten plating and also a method of applying thin coats of aluminum or aluminum alloys to iron, steel and other metals. The development of this aluminum plate will bring about radical changes in building construction, fire-proof fittings, etc. Aluminum-coated steel is not only corrosion-proof, but it is also fire-proof. Dr. Fink has solved the age-old problem of doing away with the pinholes in tinplate and in place of the old hot-dip method he uses the electrolytic method now operating on a commercial basis.

✦ ✦ ✦

DR. Fink is past president and now secretary and editor (since 1921) of The Electrochemical Society; honorary member of Tau Beta Pi; fellow of the American Association for the Advancement of Science; editor of the chapter on "Tungsten", Mineral Industry; editor of "Electrochemistry", Chemical Abstracts, American Chemical Society; contributing editor to The American Year Book (Chapter on "Electrochemistry"); member of the staff of the Metropolitan Museum of Art, New York City; member of Sigma Xi, Epsilon Chi, Phi Lambda Upsilon, American Chemical Society, American Institute of Mining and Metallurgical Engineers, and The Electrochemical Society.

✦ ✦ ✦

SINCE 1934 Dr. Fink has been a consulting electrochemist for and a member of the Electroceramic Committee of the Tennessee Valley Authority; in 1935 he was appointed consultant to the Columbia Basin Commission (Washington State). During 1936 he was Chairman of the Rare Metals Committee of the American Institute of Mining & Metallurgical Engineers; he served also on Chemistry, Eletrochemistry and Electrometallurgy Committees of the American Institute of Electrical Engineers.

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IN September, 1933, Dr. Fink was awarded the Edward Goodrich Acheson Medal and Prize by the Electrochemical Society; in January, 1934, the Perkin Medal by the Society of Chemical Industry (American Section); in June, 1936, he received from Oberlin College, at Oberlin, Ohio, the honorary degree of Doctor of Science on the occasion of the Fiftieth Anniversary of the Aluminum Industry; in August, 1936, he was the American guest speaker at the International Conference of Chemistry held at Luzerne, Switzerland.

Aluminum-Coated Steel Wire

By Dr. Colin G. Fink,

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Columbia University, New York City

Abstract

A brief account is given of the development of "Alplate" aluminum-coated steel, in particular, steel wire. Attempts in the past to produce ductile aluminum-coated steel failed due to lack of appreciation of certain fundamental characteristics of aluminum, as well as of steel. Aluminum has a very decided affinity for oxygen, even greater than that of silicon; aluminum likewise readily reacts with a host of other elements and the compounds thus produced seriously interfere with the attainment of a satisfactory aluminum-coated wire. A fundamental step in the Alplate process is the special preparation of the steel, or other metal, surface as well as the careful control of the aluminum bath in order to insure a perfect interaction and bond between the two metals. Not only must the steel surface be carefully refined, but it must be thoroughly prepacked with a gas, preferably hydrogen. The product obtained is a steel wire with a bright, silvery uniform coat of aluminum with a strong intermediate bond of aluminum-iron alloy. Alplate wire is very soft and ductile and can readily be drawn, woven and otherwise fabricated into a wide diversity of wire products. Alplate wire is not only highly resistant to corrosion, but it will resist oxidation and embrittlement at elevated temperatures almost indefinitely. On this basis Alplate wire serves as a low-cost, practical electrical resistor. ✦ ✦ ✦ ✦ ✦ ✦

Introduction

STEEL wire is one of the most widely used products of modern industry. There are a number of inherent properties of steel wire that make competition by other metal wires almost impossible. Among these properties are the very low cost, the high tensile strength and the high fatigue factor. Yet when it comes to the application of steel wire, notably to out-of-doors, for bridges or fences or screens or telephone lines, a serious objection — namely, its rapid rusting tendency—has to be contended with. This objection has been overcome in various ways, the most general one being the application to the steel surface of a protective coating of zinc,—galvanized steel wire. It was the fundamental idea of improving upon galvanized steel that suggested to us the use of aluminum in place of zinc and which led to the discovery and development of "Alplate"—a bright, silvery steel wire, soft and ductile and highly resistant to oxidation at low and elevated temperatures.

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Historical

TIME and again it has been attempted to coat steel wire with aluminum but all such attempts failed due to lack of full appreciation of the inherent characteristics of aluminum, in particular, its decided affinity for oxygen and a host of other elements, an affinity greater than that of most other metals or reagents. On account of the difficulties encountered when trying to coat steel wire with aluminum as you would with zinc or with tin, various round-about and substitute methods have been proposed in the past:

(1) Packing the steel wire in aluminum metal powder and heating to about 450° C. But the wire "becomes very brittle".[2]

(2) Heating steel wire to 1000° C. in presence of aluminum chloride vapor.[3] The wire becomes badly corroded and brittle.

(3) Spraying molten aluminum onto steel with a gun.[4] A very costly and inefficient method. Most of the aluminum is wasted.

(4) Mechanically applying an aluminum sleeve over the steel rod and then drawing down. The objection to this procedure is the high cost of aluminum tubes and the lack of any adhesion between the aluminum and the steel.[5]

(5) Electrodepositing aluminum onto steel wire from an organic bath.[6] The method is very expensive. It was difficult to get a uniform product and good adhesion between steel and aluminum.

None of the five methods enumerated above ever attained commercial importance in the steel wire field.

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The Alplate Process

IN our **Alplate** process[7] there were two primary problems involved: **First,** to apply a continuous, thoroughly adherent coating of aluminum to the steel wire surface sufficiently thick to protect the steel against corrosion and against high temperatures.

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SECOND, to produce an aluminum-coated wire that can be drawn, rolled and fabricated into various articles without destroying the coating or the wire.

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IN order to obtain a continuous, thoroughly adherent coating of

aluminum onto the steel surface a special treatment of the steel surface had to be devised, based on the following fundamental principles:

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POOR adhesion of aluminum to steel is largely due to the intervention of aluminum oxide or some other aluminum compound. The great affinity of aluminum for oxygen and other elements and the stability at elevated temperatures of the compounds formed is the reason why aluminum is used as a scavenger in the production of steel. Aluminum is more efficient than silicon as a deoxidizer;[8] it is the most efficient of all the common deoxidizers used in the steel plant.

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ACCORDINGLY, let us assume that at any point on the surface of an ordinary steel wire, immersed in a molten aluminum bath, there are atoms of iron, aluminum and carbon contending for the possession of an atom of oxygen. Now, since the affinity of aluminum for oxygen far exceeds that of either iron or of carbon, aluminum oxide is formed. This might be deduced from the following thermal data.

Al + O = 7.92	**kilocal./atom**	**of**	**oxygen**
Fe + O = 4.11	"	"	"	"
C + O = 1.82	"	"	"	"

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THESE data are based on 25° C. measurements and indicate that the affinity of aluminum for oxygen is about twice that of iron. At the temperature of molten aluminum the affinity of aluminum for oxygen is over ten times that of iron although exact values are not available. Any carbon atoms in the steel surface will not interact with the oxygen to form carbon monoxide. Quite the contrary, in the presence of an excess of aluminum the latter may capture the carbon and form aluminum carbide.

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WHAT we required, therefore, to eliminate the intervention of objectionable aluminum compounds, was a reagent that possessed an even higher affinity for oxygen than aluminum at the temperature of the molten aluminum bath. From a practical point of view there is only one such reagent available and that is atomic hydrogen.[9] At 25° C. we have for the heat of reaction: H (atomic) + O = 10.33 kilocal., which value is decidedly higher than that for aluminum oxide formation.[10] Accordingly, the next step was to get atomic hydrogen to and at the very steel surface about to be coated with aluminum.

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NOW, as is well known, iron will absorb or dissolve or combine with measurable quantities of hydrogen and the quantity of hydrogen thus taken up by iron **increases** with the temperature. A number of investigators have studied this relation between iron and hydrogen. Thus, **Sieverts**[11] observed that twelve times as much hydrogen was taken up by his iron samples heated to 1000° C. as by the same samples heated to 400° C. Accordingly, an important step in our process comprises the prepacking of the steel surface with hydrogen at, say, 1000° C. and then passing the steel into the aluminum bath, kept at a lower temperature.

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ATOMIC hydrogen exudes from the surface of the steel at the moment of contact with the cooling molten bath and a perfect union between aluminum and iron is effected. The atomic hydrogen not only prevents the formation of aluminum oxide but it will decompose any such oxide or other compound of aluminum present at the surface of the steel.

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A FURTHER detail, which is likewise important, is the elimination out of the steel surface of all elements such as carbon, sulfur, oxygen, etc., that would retard or render less efficient the action of the atomic hydrogen. Similarly, care is taken to prevent as much as possible the contamination of the aluminum bath by oxygen or other objectionable impurities and, finally, means are provided to introduce the wire into the pot of molten aluminum not through the top surface but through a very restricted opening or nozzle.

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Steps in The Alplate Process

IN the simplest case the steps of procedure are as follows: The wire leaves the reel, passes through electrolytic cleaners, washers and driers, thence into the hydrogen furnace, and from there directly into the molten aluminum bath. Thence through a wiper if specified and onto the receiving reel. Usually before fabricating the wire is given a special anneal following the coating step.

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THE hydrogen furnace serves a two-fold purpose: prepacking the steel surface with hydrogen and purifying the steel surface eliminating carbon as CH_4, sulfur as H_2S, oxygen as H_2O, etc.

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AS to the temper of the wire produced, this is medium soft, and to obtain a hard, high tensile strength, wire requires coating at, say, ⅛ inch or ¼ inch diameter and drawing down to size after coating. We have found tungsten carbide dies very serviceable for this drawing operation.

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The Aluminum-Iron Bond

IN the **Alplate** process a very intimate bond between the aluminum coat and the steel wire is obtained. This bond is not of definite composition as has been repeatedly suggested. This fact is easily demonstrated by taking a sample of Alplate steel wire and heating it at, say, 1000° C. It will be found upon examining the cross section of the wire under the microscope that the width of the alloy bond increases with the time of heating.

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SINCE the alloy bond is not of any definite composition, the proportion of aluminum to iron

varying within wide limits, advocates of the "brittle $FeAl_3$ compound" theory may interpret the ductility of Alplate to the absence of such definite compound. But the basis of ductility of Alplate lies deeper than this. Just as in the case of high silicon-aluminum alloys which were always considered brittle until **Dr. Aladar Pacz** in 1919 demonstrated that as much as 13% silicon added to aluminum produced a very ductile and malleable alloy,—just so in the case of the iron-aluminum alloys these are ductile and malleable when properly prepared. In the past the two metals were melted together and no special precautions were taken to avoid contact with air or carbonaceous or silicious materials. It so happens that in our process, when the aluminum comes in contact with the iron of the wire, all contaminating elements are practically absent and the **binary** alloy produced is ductile. We grant that the ternary alloy Al + Fe + C, or Al + Fe + O or Al + Fe + other impurity is brittle — and it is this or that ternary alloy that is usually referred to in the literature in describing "a hard, brittle alloy."

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SYKES and Bampfylde[12] found that iron containing as much as 12 per cent aluminum became ductile at 400° C. and that iron alloys with 10 to 15 per cent aluminum had a high resistance to corrosion by salt spray. According to these investigators, the amount of aluminum required to produce almost complete resistance to high-temperature oxidation is about 6 per cent aluminum for 900° C.—1000° C.; 9% Al for 1100° C. and 11% Al for 1300° C. No special precautions were taken by **Sykes and Bampfylde**[13] to eliminate traces of impurities in the iron before adding the aluminum. Accordingly, in their alloys the aluminum acted as a scavenger.

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ANOTHER point worthwhile recording in discussing the alloy bond of Alplate is that the ternary alloys Al + Fe + C are very unstable in the air in contradistinction to the binary alloys Al + Fe which are exceedingly stable—more so than either constituent.[14] **C. Sykes and H. Evans**[15] found that alloys with 11 to 16 per cent aluminum, balance iron, consist of a solid solution. This is in line with our findings in the case of Alplate, that proper heat treatment is important.

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FINALLY, as to the stability of the iron-aluminum alloys and, accordingly, of **Alplate,** at high temperatures it is not merely the protective oxide coating but it is this outstanding stability of the aluminum-iron alloys at high temperatures that plays an important role. **A. S. Russell**[16] finds the aluminum-iron alloys more stable than the tin-iron alloys, and these more stable than the zinc-iron alloys.

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Properties of Alplate

PROPERLY prepared **Alplate** wire has a silvery-white surface. It is free from pinholes or other bare spots. It is soft and ductile, highly resistant to atmospheric corrosion, the behavior in this respect being practically the same as that for solid aluminum wire.[17]

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ALPLATE wire, in particular after anodizing, is more resistant to abrasion than galvanized wire. It can be heated to 1000° C. for 1000 hours without loss of ductility.

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NICKEL wire, molybdenum wire, stainless steel wire, nichrome wire, and others, may be coated by the Alplate process thereby very appreciably improving upon the oxidation-resistant qualities of the original wires—at low and high temperatures.

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ALPLATE wire can be drawn, rolled and fabricated into a wide diversity of products. **Alplate** wire can be dyed by the same methods applied to solid aluminum.

Applications

WE mention but a few of the many tested or suggested applications of Alplate wire:

Bridge wire.
Fly screen for tropical countries.
Wire cloth as a fire-proof foundation for theater curtains.
Wire mesh for fire-proof partitions.
Wire stays for aeroplanes.
Telephone drop wires.
Core wire for aluminum cables.
High frequency current conductors.
Electrical resistor.
Fence and poultry wire.
Pin making.
Nails, pegs, rivets, etc.

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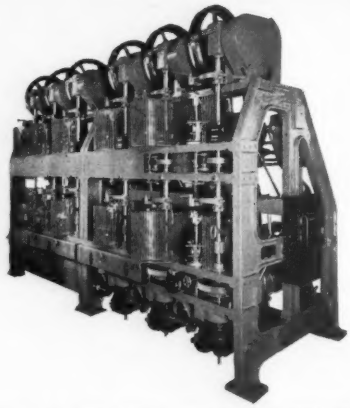
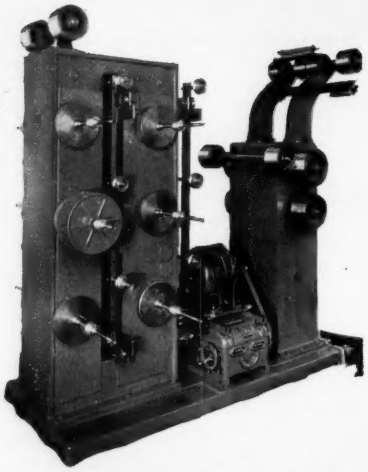


MODEL 3Q6-T-MBB TAPING MACHINE
Ball Bearing
Each Unit Individually
Motor Driven
for application of four paper tapes to each of six lines of wire.



CAPSTAN AND FINISHED WIRE REEL STAND
for one side of
MODEL H-20 ENAMELING MACHINE.
Ball Bearing, Speed Variator, Motor Drive.

EST. 1855 AIMCO INC. 1915
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517 West Huntingdon St.
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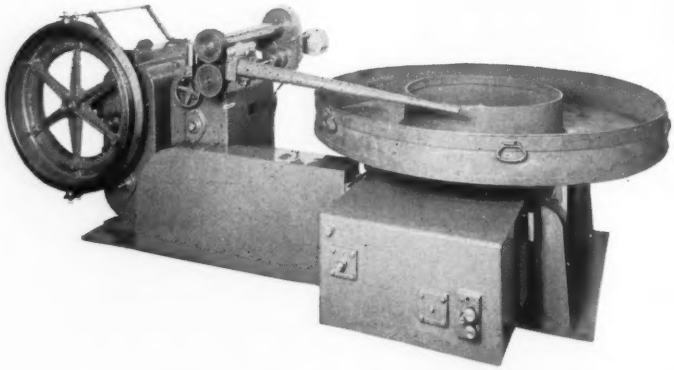
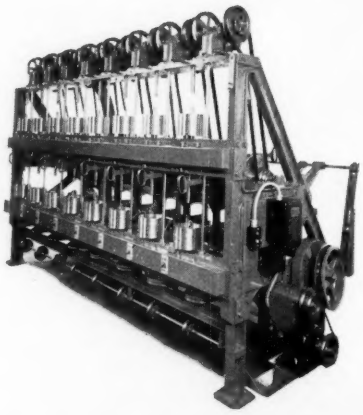


AIMCO AUTOMATIC PANNING MACHINE
Ball Bearing, for Rubber Covered Wire



MODEL 2D8-MBB MACHINE
High Speed, Ball Bearing
Each Unit Individually
Motor Driven
for application of Fiberglas, Cellophane, Cotton and Paper.

Notes on the Annealing of Copper Wire

By L. B. Barker,
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The purpose of this paper is to present a few brief comments on the annealing characteristics of commercial copper and to describe some details of furnace control which may be of interest since they relate to a type of furnace which is finding increasing application in the bright annealing of copper wire. ✦ ✦ ✦

IT would be a comparatively simple matter to set up an annealing schedule for copper wire if it were not for the fact that we must make allowance for two troublesome properties of the material: the variation in recrystallization temperature and the tendency of contacting surfaces to stick together. If the sticking tendency could be controlled or eliminated, we would anneal at a temperature high enough to allow for all possible variations in recrystallization temperatures and our furnace control would be greatly simplified. It is too bad that we cannot do it.

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VARIATIONS in recrystallization temperatures due to differences in original grain structure and degree of cold working show up prominently in the annealing of rectangular wire. We provided ourselves with an interesting picture of this problem at Schenectady by plotting the annealing curves of sixty-two samples of rectangular wire taken at random from production but representing the entire range of wire sizes and rolling setups commonly used. These samples were annealed at different temperatures from 200°C to 500°C for a total time of three hours in the furnace. The annealing was done in a laboratory furnace fitted with a 3″ x 24″ tube and a graduated heating element which provided a temperature uniform within 5°C over a 10″ length. The hardness of the annealed specimens was measured on the Rockwell 15-T scale. The spread in recrystallization temperatures was somewhat of a surprise. Two of the samples showed only a slight softening at 300°C, while three others were very appreciably softened after annealing at 200°C. The majority of the samples softened between 225°C and 275°C. It has been our practice to regard a hardness of 15-T 56 as the maximum acceptable for copper tested as annealed. On this basis 26 of the 62 samples did not anneal satisfactorily at 350°C, four of them were still too hard after the 400°C anneal, and all of them were within the limit after the 500°C anneal. It is noteworthy that three of the four samples referred to in connection with the 400°C anneal were 100 mils or under in thickness, a size which we had assumed would anneal satisfactorily at a much lower temperature.

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ANOTHER factor influencing the recrystallization temperature is the impurity content of the copper. The effect of silver additions is well known and silver bearing copper is used for many applications where it is necessary to maintain the hard drawn properties of the material at moderate temperatures. We have found, however, many instances of high recrystallization temperatures which could not be ascribed to the silver content nor to any variation in previous treatment. Copper received in the form of ¼″ rod and drawn to sizes as large as .064″ will normally undergo a full anneal in our enameling ovens. The failure of occasional lots of wire to anneal under these conditions, which are very uniform as to time and temperature, indicated the desirability of classifying our rod stock on the basis of annealing characteristics. The test developed for this purpose consists in rolling samples of the rod as received to a thickness of .070″, without intermediate anneals, annealing the samples at 275°C in a salt bath for 15 minutes, and testing for hardness. On the Rockwell 15-T scale full hard copper will test about 83, normal soft copper 52 to 54, and over-annealed copper as low as 42. Samples which tested 80 or over were assumed to have recrystallization temperatures which were too high for the larger sizes of hard wire for enameling and such lots were segregated for use on other jobs. Comparative tests in the enameling room together with experience extending over a period of nearly 15 months have demonstrated the effectiveness of the test.

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A LARGE number of samples selected for their varying response to the above test were sent to the spectrographic laboratory and an effort made to determine what impurities caused the increase in recrystallization temperature. The results were negative. At first silver was indicated, but later analysis showed that samples which were identical in silver content as nearly as could be determined by the spectrograph were possessed of widely different recrystallization temperatures. Variations in other elements showed no consistent relationship to the annealing characteristics. Our results were confirmed by the re-

search laboratory of the refinery which cooperated with us in the investigation. The only positive result of the investigation lay in the statistics we accumulated on the products of different refineries. Rejections, or rather segregations, based on the annealing test and extending over a period of more than six months varied from 4% of carloads received for the brand with the best showing to 63% for the one with the poorest showing. The majority of the samples tested had a hardness after annealing of between 15-T 60 to 70. The minimum, which occurred only once, was 59. Differences in hot rolling practice apparently are without influence. A number of the brands were rolled in three different mills and we found the properties to be the same regardless of which mill did the rolling. Conductivity tests were made on a number of the samples representing extremes in annealing characteristics but no significant deviations from standard values were found. It seemed remarkable to us that impurities other than silver could have such a marked effect on the recrystallization temperature without causing a noticeable decrease in conductivity.

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OUR experience with the bell type annealing furnace has been very satisfactory and this includes the combustion type atmosphere controller. The temperature control on the first group of furnaces installed employed a fixed thermocouple so placed that it followed the temperature of the gas rather than that of the load. In the case of 500 lb. strander bobbins with 15 bobbins in the load, the annealing procedure was to continue the heating period for three hours after the control thermocouple had reached 400°C, which was also the setting on the control pyrometer. The temperature of the furnace atmosphere was thus held to a maximum of 400°C throughout the heating period. We found that under these conditions the finishing temperature of the copper as measured by thermocouples wound into the reels varied from 285°C to 340°C. A spread of 55°C in finishing temperature would have little significance if we were annealing in a range which was safely above the variations in recrystallization temperatures previously referred to but that could never be done with stranding wire, at least not under our conditions. The sticking tendency limits the temperature and, unfortunately, the cleaner the wire the more it sticks. We determined that wire for our stranders should be annealed to at least 325°C actual wire temperature and that no difficulty from stickiness would occur if the temperature of the outer turns were limited to a wire temperature of approximately 375°C.

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THE temperature control system finally worked out to accomplish this employs flexible thermocouples placed in direct contact with the load. Each base is fitted with three thermocouples. Two of these operate the furnace control pyrometer which is a two point instrument. Either thermocouple on reaching the control temperature will shut off the power and maintain the temperature by the usual "on and off" cycle. When in position on the load one thermocouple is placed at the top and the other at the bottom. This arrangement has a number of advantages. The furnace atmosphere at the beginning of the heating period reaches a higher temperature than would be the case if the temperature of the atmosphere were controlled directly. The higher temperature gradient increases the heating rate and less time is taken to bring the load to the desired temperature. If one part of the load heats up faster than the rest, it is held at a safe maximum temperature while the remainder of the load continues heating. This is quite often the case with loads of mixed reels and coils in which it is difficult to provide normal circulation of the gas. Loads of this type are annealed without difficulty. The third thermocouple is connected to a multipoint recorder where it provides a complete record of the entire heating and cooling cycle of the load. It is usually placed inside a reel or buried in a coil where it follows very closely the actual temperature of the copper. The record it makes shows when the load is up to temperature and when it is cool enough to have the hood removed. This latter function is important in reducing the length of the cooling period, as the hood can be removed at the maximum safe "take out" temperature.

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IN connection with the atmosphere controller, we permitted ourselves a luxury item which turned out very well. This is a combustible gas alarm connected with a recorder so that we have in effect a recording gas analyzer. The record made is on an arbitrary 0-100 scale but we have determined by experience the correct operating range. We are getting uniformly bright wire with no discernible difference between the color of the wire as drawn and as annealed. Copper temperatures in some cases reach 500°C. At one time we experienced some difficulty with sulphide discoloration.

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AN investigation indicated quite conclusively that this was caused by a combination of two factors, the sulphur content of the drawing compound and the hydrogen content of the gas. Good practice obviously requires that both be kept at a minimum. We hold the CO of the gas to under .5% and the hydrogen to under 1%, using the recorder as a guide, and we also permit the gas to flow through the load at purging velocity during the entire heating period. Results are very consistent and are probably due to the small amount of hydrogen present combined with a rapid removal of any vapors given off by the load as it heats up. The grease remaining in the bearings of strander bobbins does not seem to be detrimental, although it may account for the occasional traces of sulphide discoloration that have been observed. Flat wire anneals with no change in color. This wire is rolled "wet," that is, with a lubricant applied to the surfaces of the rolls. Oil containing no free sulphur is regularly used, but no trouble with discoloration occurred when a light lubricating oil was used.

(*Please turn to Page 642*)

ACID DISPOSAL SYMPOSIUM

Vol. 13 OCTOBER, 1938 No. 10

Disposal of Waste Pickle Liquor

By Otto Mantius,

Consulting Engineer, Acid Recovery Dept.,
National Lead Company, New York, N. Y.

A comparison of the various methods of the disposal of waste acid with discussions of costs and economies effected by various disposal processes.

Consumption of Acid

ACCORDING to government statistics the Iron and Steel Industry used about 800,000 tons of 50° Be. acid in 1929; the average yearly consumption for the last 15 years has been given as 590,000 tons, equivalent to about 367,000 tons of H_2SO_4. At the present time from 20% to 40% of this acid cannot be recovered as it is lost by drag-out in the wash-water. The average loss could easily be reduced to 20% which would mean a recovery of 294,000 tons of H_2SO_4 in the form of dilute H_2SO_4 and ferrous sulphate ($FeSO_4$) which can be converted into H_2SO_4. Based on information given by numerous mills the waste pickle liquor contains from 1% to 9% of H_2SO_4 and from 16% to 22% of $FeSO_4$; the average should be about 6% H_2SO_4 and 18% $FeSO_4$, which represents 100,000 tons of H_2SO_4 in the form of dilute acid and 194,000 tons of H_2SO_4 as $FeSO_4$ equivalent to 300,000 tons of ferrous sulphate.

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Disposal of Acid

WITH suitable equipment the mills could recover about 27% of the total acid used for pickling, and the ferrous sulphate could be sold as copperas, or converted into H_2SO_4 in a contact or chamber plant. Unfortunately, any recovery process requires considerable quantities of either steam, fuel or power, but the complete neutralization of the waste acid is also quite expensive and the disposal of the neutral waste frequently presents great difficulties.

OTTO MANTIUS

Born and educated in Germany. Studied at the Universities of Hannover and Charlottenburg, and graduated in 1899. Came to the United States in 1905, and from 1906 to 1915 was chief engineer of the American Foundry & Machine Company in Chicago, and the Zaremba Company at Buffalo, New York.

In 1915 established own consulting business in New York, specializing in the design and building of chemical plants and machinery.

For the past eighteen years specialized in building plants for the recovery and concentration of waste sulphuric acid in cooperation with the National Lead Company, which holds exclusive rights for the sale of his patented processes.

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IN any case, small plants using only a few tons of acid per week can only dispose of the waste pickle liquor by complete neutralization unless they can ship the acid to a nearby reclaiming plant.

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SOME mills also use muriatic and hydrofluoric acid and such waste acids should not be mixed with the ordinary pickling acid but treated separately, either by concentration or by complete neutralization.

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WE have built Acid Recovery Plants for more than eighteen years and our evaporators and concentrators handle nearly 10,000 tons of various waste acids per day. After careful investigation of numerous methods used or proposed for the handling of waste pickle liquor, we believe that the steel mills should insist on a process whereby the free acid is recovered in such a state that it can be used again for pickling, and the ferrous sulfate is reclaimed in the

form of either marketable copperas, or monohydrate suitable for the manufacture of new acid.

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Methods of Disposal

1. Neutralization

a. Lime:

IN locations where it is prohibited to discharge the waste acid into the sewers it is necessary for the mills to neutralize the effluent with limestone or lime. Ordinary limestone is not very effective, and the use of lime is quite expensive because in most States not only the free acid but also the sulfates must be neutralized as they will absorb oxygen from the water. Such treatment requires about 1000 lbs. of lime for each 1000 gallons of liquor and a large volume of water is required to carry off such waste, as in stagnant waters the iron hydroxide formed by the neutralization of the ferrous sulfate will appear as a dirty scum on the surface.

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THE washwaters discharged from the picklers and containing about 20% of the total acid used cannot be recovered economically, and must therefore be neutralized; in most cases waste caustic is available for this purpose.

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b. Slag:

IN some mills the waste pickle liquor is pumped on top of the slag piles, but this method gives only temporary relief as gradually the ground becomes saturated with acid, endangering the water supply for miles around the plant.

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c. Scrap Iron—Flow Diagram 'A'

FOR more than 30 years some of the large tube and wire mills have disposed of their waste liquors by neutralizing or "killing" the free acid in the effluent with scrap iron. After proper settling the almost neutral liquor containing ferrous sulfate and all impurities in solution is evaporated under vacuum in double-effect evaporators to the point where the ferrous sulfate starts to crystallize out in the form of copperas ($FeSO_4 \cdot 7H_2O$). The solution is cooled in batch or continuous crystallizers and the copperas is separated from the mother liquor in centrifugals. Usually the copperas has been sold without further drying, but in some instances the water of crystallization has been reduced from $7H_2O$ to about $4H_2O$ to obtain a free flowing material which is not hygroscopic like copperas. The mother liquor is returned to the evaporators.

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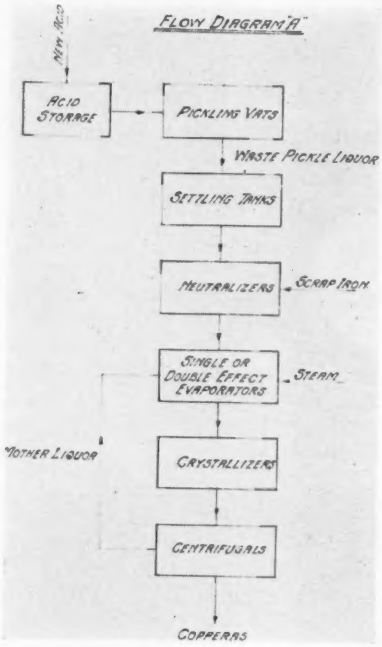

THIS method eliminates completely the pollution of rivers and streams, but operating costs are quite high due to the considerable tonnage of valuable scrap iron required for neutralization. Maintenance charges are excessive as it is not possible to completely neutralize the free acid, and because the various apparatus have not been built of acid-resisting materials. Further, by this method none of the free acid is recovered and only a small amount of the copperas can be sold at a profit. Actual costs of production are much higher than the value of the sulphur in the copperas.

2. Crystallization — Flow Diagram 'B'

THIS process was used in the United States by Marsh and Cochran and in Europe by Zahn & Co. (Agde Process) and Sulfrian. After suitable settling or filtration the pickle liquor is cooled either by mechanical refrigeration or under a high vacuum to a point where from 50% to 70% of the ferrous sulfate crystallizes out as copperas which is then removed in centrifugals. The mother liquor containing all the free acid with its impurities and inhibitor, and also a certain amount of ferrous sulfate is returned to the pickling vats. This process is very simple and reasonably low in first cost and operating expenses. We have been informed that about 20 plants of this type have been installed in Europe with quite satisfactory results, but the reclaimed acid must be handled in lead or rubber lined tanks and pipes which adds to the cost of the plant and increases maintenance charges.

+ + +

HOWEVER, in this country the process has been a complete failure as with constant re-use the returned acid contained certain impurities (mostly metallic sulfates) which would plate out on the sheets and cause spots and streaks on the finished plates which were very objectionable. The steel mills claim that the specifications are very much stricter in this country than in Europe and they object very strenuously to the reuse of the recovered acid as long as it contains such accumulated impurities.

+ + +

IN some instances the waste pickle liquor is rather weak which would result in a low yield of copperas crystals, and to overcome this difficulty the acid is first concentrated and then cooled (Lurgi system) which means additional equipment. In other plants the weak acid is reinforced with new acid which has the objectionable feature that then all the acid is contaminated.

WASTE acids frequently contain copper sulfate and this can be removed by treating the acid with hydrogen sulfide or iron sulfide, but the filtration of the copper sulfide resulting from this treatment is extremely difficult and the equipment quite expensive.

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3. Evaporation

a. By Direct Heat—Flow Diagram C

IN the process proposed by the Chemical Construction Co. the free acid in the waste pickle liquor is neutralized with iron oxide cinders and the mixture evaporated to dryness in a dehydrator which is heated directly with coal, oil or gas. The granular sulfates are then mixed with Pyrites and roasted at a temperature of over 1400°F. The sulfates and sulfides are decomposed into sulphur dioxide and trioxide and iron oxide. The sulphur trioxide is reduced to dioxide (SO_2) by the addition of coal and the SO_2 is conducted to a contact plant where it is oxidized to SO_3 and then converted into H_2SO_4.

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BY this process the impure acid and the ferrous sulfate in the pickle liquor are converted into sulphuric acid of excellent quality and all impurities are discarded with the cinders. However, first cost and operating expenses are very high as the free acid is not returned to the pickling vats but all the water has to be evaporated, the inhibitor is destroyed, the SO_3 must be reduced to SO_2 and then again oxidized to SO_3. Plants of this type are extremely costly and the dehydrator produces only ferrous sulphate but not copperas. To handle the additional amount of ferrous sulfate produced by the neutralization of the free acid the capacity of the contact plant must be increased 35%.

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b. By Steam—Flow Diagram 'D'

THE **National Lead Company** proposes a process by which the free acid is recovered and purified so that for all practical purposes it is equal to new acid and the ferrous sulfate is reclaimed either as copperas or as ferrous sulfate monohydrate. For this purpose the filtered or settled waste pickle liquor is concentrated in two steps. In the first step the waste acid, to which has been added the monohydrate coming from the second stage, is evaporated in a double effect evaporator under vacuum to about 28% H_2SO_4. Approximately 80% of the ferrous sulfate crystallizes out in the form of copperas which is separated from the mother liquor in a centrifugal. This 28% acid is then further concentrated in the second step to 54° Be. (68% acidity) at which point the impurities of metallic sulfates become practically insoluble in the acid and are separated from the acid in a filter or centrifugal together with the ferrous sulfate. These sulfates are dissolved again in the waste pickle liquor and are gradually discharged with the copperas.

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THE acid could also be concentrated to 60 or 66° Be., but the extra expense is not warranted as the solubility of the sulfates changes very little above 54° Be. Besides acid of this strength can be handled in tanks and pipe lines of steel; no lead or rubber lining is required.

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WE have found that 54° Be. acid will contain not more than 0.35% of iron, copper and nickel, and this quantity is negligible especially in view of the fact that even the purest new acid will be contaminated as soon as it enters the pickling vats.

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THE reclaimed acid can be mixed with the new acid, or if the mill wants to be on the safe side, it can be used for the pickling of billets, rods and other material where a bright finish is not required. It could also be used for the washing of benzol or sold to fertilizer plants which do not require a clean acid.

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WHILE the **National Lead Company** has not so far installed a plant to recover waste pickle liquor, the process substantially as outlined in the previous paragraphs has been used successfully in the chemical industry on similar waste acids, for more than four years. The plants in operation and under construction handle more than 1400 tons of waste acid per day, recovering about 250 tons of H_2SO_4 in the form of 54°, 60° and 65° acid, and produce about 200 tons of sulfates.

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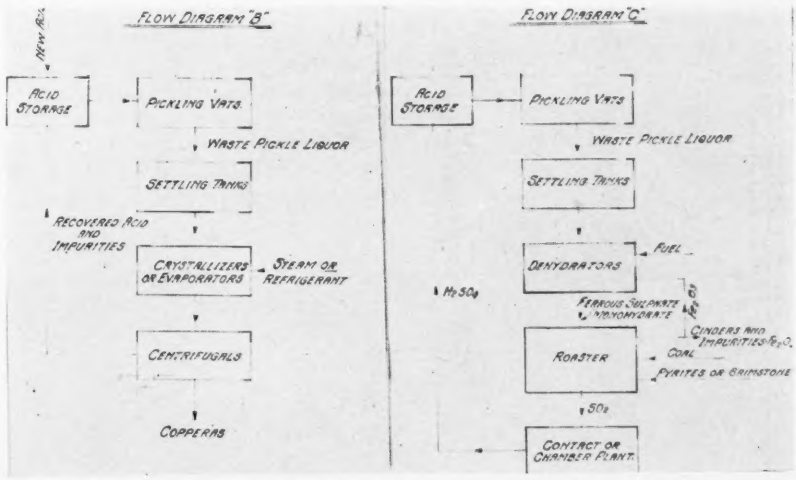
c. By Steam with Partial Neutralization

A VARIATION of method 3-b is shown on Flow Diagram 'E'. The waste acid is concentrated in a single or double effect evaporator to about 28% acidity, the copperas



is separated by a centrifugal and the acid is used again for pickling. In this case the impurities are returned again to the pickling vats and accumulate gradually. Simple tests will show very quickly whether or not the 28% acid is suitable for pickling, and as soon as the accumulation of the impurities reaches the danger point the concentrated acid is not returned to the plant but is neutralized with scrap iron. The neutralizer can be quite small as the original volume of the pickle liquor has been reduced to about one-fifth and the neutralization is completed in less than two hours. A small amount of hot condensate is added to prevent supersaturation. The almost neutral solution is evaporated, the copperas and impurities separated and the mother liquor returned to the neutralizer.

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BY this method from 80% to 90% of the free acid is recovered, and the impurities cannot accumulate to the danger point as they are removed completely at certain intervals. The length of such periods depends entirely on local conditions and will vary between five and ten days or perhaps longer.

THE operating cost of this type of plant is slightly higher than process 3-b in case the acid has to be neutralized frequently to remove the impurities, but the first cost is much less. This method is suitable for small mills and in plants where 68% acid cannot be reused.

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d. Miscellaneous Methods.

FROM time to time numerous other methods have been proposed for the recovery of the valuable acid from the waste liquor. In one process the acid is heated to 300° F., which will cause the precipitation of all sulfates, but the filtration has to be done under pressure and the remaining fine mud retains so much acid that the actual acid recovery is only a few percent of the total. Another method calls for the mixing of the waste pickle acid with concentrated new acid in order to precipitate the ferrous sulfate as monohydrate but here again no impurities are removed and all the acid is contaminated; further, a large quantity of acid is lost with the very fine precipitate.

SOME large steel mills have installed electrolytic picklers where some of the ferrous sulfate is converted again into active acid and metallic iron. The manufacturer of this system claims a large saving in total acid consumption but this process does not provide for any method of disposal of the pickle liquor.

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Disposal of Copperas

ASSUMING that all the waste pickle liquor is neutrallized with scrap iron as described under method 1-c, the steel industry would have to dispose of not less than 850,000 tons of copperas ($FeSO_4.7H_2O$) per year. This quantity can be reduced to 570,000 tons if the free acid is recovered and reused, resulting in a saving of 100,000 tons of H_2SO_4 (129,000 tons 60° acid) and about 55,000 tons of scrap iron.

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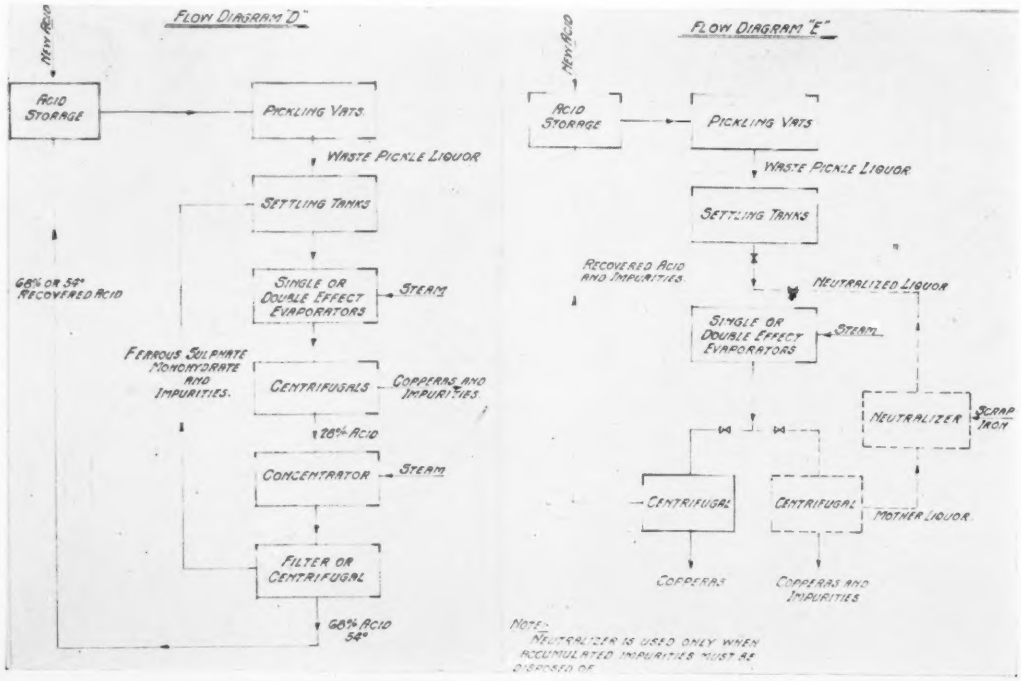
THE nominal market price of copperas is about $12 per ton but only a fraction of the total output can be sold at this price. In order to dispose of the balance, it must be converted into new acid



which is returned again to the pickling process. Assuming that sulphur in the form of brimstone or pyrites has a value of $18 per ton, copperas ($FeSO_4.7H_2O$) should cost not more than $2 per ton and after drying to monohydrate ($FeSO_4.1H_2O$) about $3.40 per ton.

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IN some plants the copperas is now passed through a steam or direct heat dryer to remove 2 or 3 molecules of water as a product with 4 or 5 molecules is free flowing and not hygroscopic like copperas. For the purpose of acid manufacture the copperas should be dried to monohydrate ($FeSO_4.1H_2O$) to reduce freight charges.

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THE monohydrate is roasted in a kiln together with a suitable amount of pyrites or brimstone and the SO_2 gas is oxidized in a contact or chamber plant to SO_3. Such a plant must have a carefully designed purification system which adds considerably to the first cost of the plant and also the operating cost. In mills where the free acid is reused, the contact plant must produce 73 lbs. of acid for every 100 lbs. of acid used for pickling, while in plants where all the acid is neutralized with either scrap iron or iron oxide the contact plant must have the full capacity of 100 lbs. In the first case the relation between acid from pyrites or brimstone and acid from monohydrate is 1:2.7; in the second case 1:4 which increases the total cost of acid $1 to $2 per ton, due to the extra expense in handling the sulfates.

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LARGE steel mills could install their own contact or chamber plants provided they are built in at least two independent units to accommodate the variable output of the mill. Smaller mills should make an arrangement with an existent acid plant for the exchange of ferrous sulfate against new acid or build a conveniently located community plant. Monohydrate may be shipped in special tank cars or for short distances in closed steel containers loaded on trucks.

FERROUS sulfate may be converted into Calcium, Sodium, Ammonium and other sulfates without serious difficulties, but all these processes involve extra expense for evaporation of additional water, and the filtration of the resulting iron hydroxide or carbonate is very difficult.

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IT has also been proposed to decompose ferrous sulfate solutions by electrolysis but the current consumption is entirely too high and the process uneconomical.

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Economical Aspects

THE pickling of iron and steel must be done with dilute acid and the disposal or reclamation of the waste liquor requires the evaporation of large amounts of water. Further, the value of the recovered products is quite low and all equipment must be made of acid resisting material. In addition the recovery plant must be large enough to take care of the full capacity of the mill. All these factors contribute to the high first cost and operating expenses of a disposal plant.

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CONFRONTED with the low value of the copperas it is essential to recover the free acid by a method which will prevent an accumulation of impurities detrimental to the pickling process. Ordinarily the value of the reclaimed acid will pay for the operating cost of the plant and the ferrous sulfate can be produced at a cost of from $1.50 to $2.00 per ton, leaving a margin of about $1.00 per ton in case the sulfate is used for the manufacture of new acid. With the low cost of copperas in plants where the acid is reused it might be possible to increase the market for this product as it could be sold at a reasonable profit even at a price of $4.00 per ton instead of the present price of $12.00.

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THE cheapest recovery process consists of reinforcing the waste pickle liquor with new acid and then crystallizing or evaporating the solution but all the acid is contaminated. Next in economy are the methods shown on Flow Diagrams 'D' and 'E'. The most expensive process is illustrated by Flow Diagram 'C', and it also requires the largest contact plant.

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IN all mills where the acid is not recovered, the operator of the pickling vats usually has instructions to run the strength of the acid down to the lowest possible level. This procedure is quite uneconomical as it requires extra steam and time and is not necessary after the installation of a reclaiming plant. Continuous picklers should be arranged so that the fresh acid enters one end at a uniform strength and the waste pickle liquor is withdrawn continuously from the other end.

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THE quantity of acid lost in the washwater could be reduced by the installation of squee-gee rolls and wipers. Batch treaters could be operated at higher average strength allowing more time for dripping.

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THE waste liquor should not be discharged into special sewers, as the first cost and upkeep is very expensive; chemical plants handle all acids in overhead lines and tanks, either lead or rubber lined. The waste acid can also be handled quite economically in rubber lined tank cars instead of long pipe lines.

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FORTY years ago the packing houses were forced by the authorities to install evaporating and drying equipment to recover the waste liquors going into the sewers and this has developed into a very profitable industry. About twenty years later the oil industry which uses about 1500 tons of acid per day was confronted with the same problem, and there is no doubt but that the time has come for the steel industry also to take steps regarding the recovery and utilization of the waste pickle liquor. The solution of this problem requires close cooperation between the steel mills and the equipment manufacturers.

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Modern Pickle Liquor Recovery

By S. F. Spangler and Dr. N. Titlestad,

Chemical Engineer, Chemical Engineer,
Chemical Construction Corporation, New York, N. Y.

A description of the process for the recovery of sulphuric acid from waste pickle liquors, as developed by the Chemical Construction Corporation.

THE disposal of waste products has gradually come to the foreground as one of the most important problems of the present industrial age. Previously, when American industries were in their infancy, the population scattered and the production small, it was easy to dump waste materials. Today with huge plants erected at highly industrialized centers of population, the disposal problem has become increasingly difficult. While each industry undoubtedly has its own problems in this respect, we shall deal here solely with the disposal of the waste liquors produced in the pickling of iron and steel products with sulphuric acid.

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DR. NICOLAY TITLESTAD

Born in Norway; educated there and in Germany. Graduated 1909, Technical Institute, Braunschweig, Germany, with degree Dr. Ing. 1910-1915, Research and Development Engineer with Norsk Hydroelektrisk Kvaelstof, A/S, Rjukan, Norway, serving as Local Manager of Experimental Plant. 1915-1924, Consulting Engineer. Visited U. S. A. in 1916, moved to this country in 1923, since naturalized. Since 1924, Chemical Engineer with Chemical Construction Corporation, formerly at Charlotte, N. C., office and since 1934 at New York Office, specializing in development and acid plant design. Inventor and co-inventor of various chemical processes and items of equipment.

THIS waste pickle liquor may be considered a form of spent acid, as known to chemical industry, though that term covers a much wider class of materials resulting from the use of acids and includes, for example, the sulphuric acid- sodium sulphate solutions of the rayon industry, the nitric and sulphuric acid mixtures resulting from nitration operations such as gun-cotton manufacture, and the mixture of iron sulphate and sulphuric acid produced in the manufacture of titanium oxide pigments. This titanium pigment spent acid is very similar to steel mill pickle liquors, containing the same major constituents but in different proportions.

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IN the steel industry, the iron oxide coating is removed from rolled plates and other steel products by immersing them in a dilute sulphuric acid bath. This operation, which may be performed either in batches or continuously, is known as pickling. The iron oxide is dissolved as ferrous sulphate. As the concentration of the ferrous sulphate in the solution increases, more and more acid is added until a point is reached at which the solution has lost its power to dissolve more oxide and must be discarded. Average compositions of this solution, commonly referred to as "pickle liquor," when discarding is necessary are 3 to 8% sulphuric acid and 10 to 20% ferrous sulphate.

FOR many years, large numbers of chemists and engineers have been confronted with the desirability, and more recently with the necessity, of solving this problem of economical disposal of this pickle liquor preferably with recovery of usable by-products. Naturally they have attacked it from various angles.

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IF spent acids are relatively free from other compounds or salts, the recovery of clean strong acid for reuse may be accomplished by simple concentration or evaporation procedure which varies some-

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what depending upon the nature of the spent acid. But, if they contain large quantities of salts or other impurities, as is the case with pickle liquor, they cannot be concentrated without encountering great difficulties. More involved recovery processes become necessary.

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THE first point requiring consideration by the engineer is the economics of the proposed recovery operation. Pickle liquor contains sulphuric acid and iron sulphate, both relatively cheap commodities. There is a large market for sulphuric acid, but the outlet for iron sulphate in the form of copperas or crystallized ferrous sulphate is rather limited, and when large quantities are offered for sale, the market price of this material rapidly approaches zero.

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MANY attempts at dealing with this disposal and recovery problem have been based on the neutralization of the free or uncombined sulphuric acid, with or without the recovery of the iron sulphate as copperas by crystallization. When merely neutralization is resorted to, it leads to an incomplete and uneconomical result. In the first place, it is necessary to employ lime or other alkaline materials for the purpose, which costs money. Secondly, the process requires considerable equipment, representing an investment charge, and finally, it requires labor, power, water and upkeep, all items representing expenditures without any return except elimination of a nuisance. The precipitate obtained by the use of lime as a neutralizing agent is filtered off and the resulting liquor containing iron sulphate is discharged into the sewer or rivers. Here hydrolysis takes place, and the problem of stream pollution is still unsolved.

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VARIOUS methods of concentration and crystallization have been tried out. Besides the problem of disposal or sale of the iron sulphate as mentioned above, this procedure involves chemical and engineering difficulties. In the first place, we find that this concentrating problem is of a complex nature. This will easily be understood by any chemical engineer familiar with crystallizing technique when he consults the solubility curves for iron sulphate in sulphuric acid. These curves show that under certain conditions the salt containing seven molecules of water, known as copperas, is obtained, but under other conditions salts are obtained containing one molecule of water or eventually two or four molecules of water. A low acid concentration and a low temperature favor the formation of heptahydrate (copperas), whereas a high acid concentration or a high temperature, or both, favors the formation of monohydrate or dihydrate. The location of the breaking points between the different types of crystals at inconvenient temperatures or concentrations makes the application of the conventional concentrating and crystallizing methods somewhat difficult to carry out in practice. The presence of free acid in the liquors also introduces a corrosion problem which is not easily solved, and necessitates going to equipment designs which are defective economically and structurally. The acid, of course, takes its toll and is responsible for a high upkeep and renewal expense.

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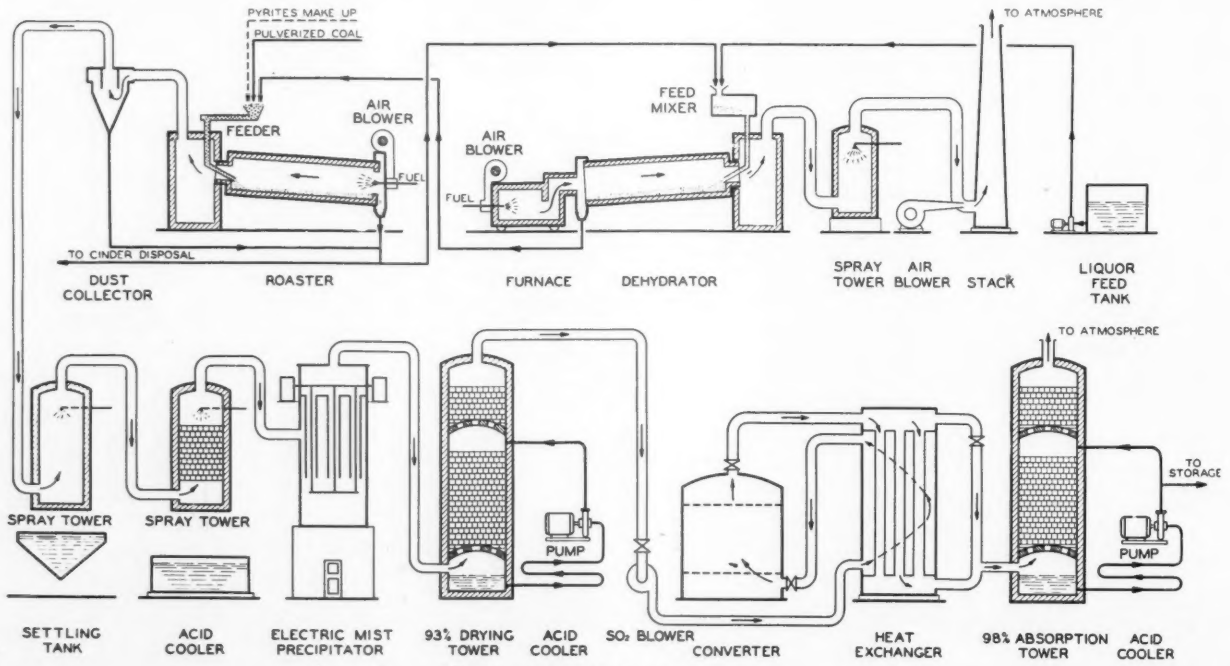
ANOTHER disadvantage of the crystallizing method lies in the



"Chemico" Sulphuric Acid Contact Process
(Using Waste Sulphate Liquor)

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fact that only a part of the sulphate can be separated out. In those cases where the pickle liquors available have a high concentration of $FeSO_4$ and a low concentration of H_2SO_4, crystallizing processes may be relatively efficient but when the sulphate concentration is low and the acid concentration high, the efficiency or removal of sulphate per cycle is usually low. In such a re-cycling operation the mother liquor from the precipitated heptahydrate will be high in ferrous sulphate, and this will have to be returned to the pickling vats for reuse. It will be found that in those cases where it is desirable to pickle with a bath containing not over 20% of $FeSO_4$ and 5% of H_2SO_4, this composition will be difficult to maintain when using the crystallizing process. One point which is of importance to consider in connection with the recycling of such liquors is that there is always the chance of accumulating some impurities which will work as inhibitors on the subsequent pickling process. It will, therefore, be found that if a system of recovery by crystallization is to be installed in connection with the steel pickling plant, there will also have to be a change in the method of pickling or the composition of the pickling bath.

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ONE process has been suggested recently of this type. This comprises using hot concentrated pickle solutions and blowing the liquor with cold air; the liquor will be cooled by evaporation of part of the water and some copperas will crystallize out. There probably is very little that is new in this process as cooling by air was already tried by one of the independent steel mills as far back as in 1932 or 1933, and the use of hot concentrated pickle liquor for pickling was also carried out by several steel mills. The same results can also be obtained by using vacuum crystallization instead of crystallization by air cooling. The drawbacks are the same in general.

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RECENTLY another recovery process has been developed which has received notice in the technical press. This is described in an article in "Steel," dated July 25th, 1938, which states that a commercial installation will soon be placed in operation. This method involves controlled precipitation of all the acid and sulphate contained in the pickle liquor by means of alkaline materials. By this precipitation there is claimed to be obtained after subsequent treatment a product suitable for insulating or building materials. From the data given in the article, it appears that this process would deliver about 2.8 tons of insulating material per ton of total equivalent acid contained in the pickling liquor. It is estimated that the total pickle liquor available from normal operations in this country is approximately 500,000 gallons per day. If we assume an average of 5 to 6% free sulphuric acid and 20% $FeSO_4$, it would be equivalent to about 500 tons of acid per day. Supposing that all the pickle liquors are worked up in this manner, it would mean the production of 1400 tons of insulating material per day or some 500,000 tons per year. When we add to this amount the quantity of materials of similar character that are now being produced from other waste sulphates and gypsum, the amount of such insulating and building materials available for the market would far exceed the demand, resulting in keen competition and low prices.

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FROM an economic standpoint, therefore, this new process, like processes involving the recovery of copperas, can only be considered satisfactory as long as it is not adopted generally on a large scale.

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WHEN large scale disposal and recovery is involved, economic considerations dictate the adoption of a process that recovers only materials that can be reused or readily sold. This means that all the sulphate content of pickle liquor, both that present as free sulphuric acid and that present in the combined form as ferrous sulphate, should be recovered as sulphuric acid and the iron also recovered in a usable form. The possibility of producing sulphuric acid from ferrous sulphate has been studied for many years, but only in recent years has this been done successfully on a commercial scale.

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THESE initial installations of this process, controlled by the Chemical Construction Corporation of New York and known as the "Chemico" Sulphate Conversion Process, have been described in articles by S. F. Spangler in "Chemical & Metallurgical Engineering" (March 1935), "Iron Age" (April 11, 1935) and "Steel (April 15, 1935). They were erected to handle the spent liquors containing free sulphuric acid and iron sulphate obtained in the treatment of titanium ores for the manufacture of titanium-oxide pigment. This process is usually adaptable to the pickle liquors produced by steel mills and consists briefly of the following procedure:

1. **A continuous process of dehydration and neutralization of the pickle liquor to form a relatively dry sulphate.**
2. **Roasting of this material to produce SO_2 gases of high concentration.**
3. **Processing these gases in a contact sulphuric acid plant for the manufacture of sulphuric acid.**

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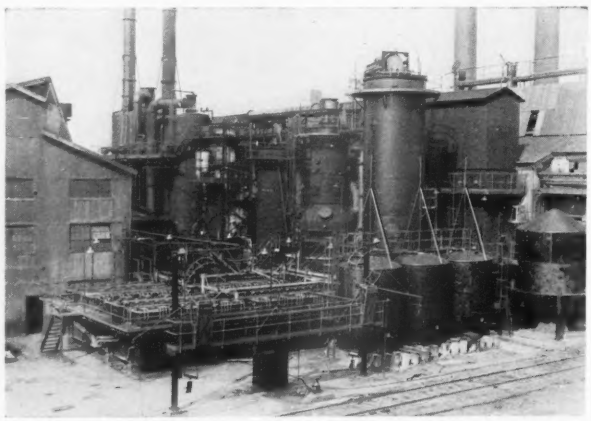
AS the technical details of this process are widely known, having been described in recent texts on sulphuric acid manufacture and other magazine articles in addition to those mentioned above, they will not be repeated here. The illustrations with this article include a flow diagram of the process and views of the large installation at Sayreville, N. J., operating on titanium pigment spent liquors. This Sayreville Plant was built in 1935 to produce approximately 120 tons of strong sulphuric acid per day and has recently been doubled in capacity. Improvements in equipment have been made over the original installation, but the basic operating principles remain

the same. Two of these, developed after thorough study of all available methods by the engineers of Chemical Construction Corporation, are worthy of special emphasis. In the first place, the neutralization and dehydration is carried out in one continuous step in a rotary kiln directly heated by combustion gases, thus obtaining a higher fuel efficiency than is possible in indirectly heated equipment and permitting the use of cinder dust from the roasting section of the plant for the neutralization of the free acid. The other major principle involves conducting the roasting of the sulphate under reducing conditions and at relatively low temperatures, resulting in low fuel consumption and the production of a gas high in sulphur dioxide content and practically free from sulphur trioxide, which greatly simplify subsequent conversion of the gas into acid.



Portion of recently enlarged "Chemico" Sulphate Conversion Plant at Sayreville, N. J.

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THIS process offers advantages over any of the other methods known up to this time, in that it processes all of the sulphur compounds contained in the pickle liquor through a gaseous phase to fresh acid and does not return any of the liquor as such. The danger of returning inhibitors to the pickling vats is thereby eliminated. It follows as a natural consequence that when using this process the pickle liquor concentration and the method can be maintained as desired. However, it is quite obvious that the higher the concentration of sulphate and acid in the pickle liquor produced, the lower will be the cost of conversion to fresh acid because of the smaller quantity of water to be removed by evaporation. Consequently, a strong pickle liquor would mean a lower initial investment cost of the conversion plant as well as lower operating cost.

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WITH this "Chemico" process an iron oxide cinder is produced in addition to the sulphuric acid. This cinder usually contains between 0.3 to 1% of sulphur. The oxide obtained from the roasting process should be particularly suitable for use in the steel industry. The criticism has been made that the sulphur content of the cinder is too high for use of the cinder as blast furnace charge, but if we consider the small amount of cinder produced as compared to the amount of ore going to the blast furnace, its effect on the sulphur content of the total is seen to be quite negligible. Before the cinder is charged to the blast furnace, it is desirable that it be sintered. Many steel mills have their own ore sintering machines, and the cinder from the roasting would be particularly suited for admixture at the sintering plant if it is not sintered separately. Inasmuch as the sulphur is very loosely combined, the cinder can be almost completely desulphurized by sintering.

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BESIDES the two products, — sulphuric acid and iron oxide cinder, — the "Chemico" process produces no residual materials requiring disposal. Naturally there are unavoidable stack gases and small amounts of effluent liquors to remove along with the cooling water. The gases exhausted to the atmosphere from the system are of the same nature as those exhausted to the atmosphere from any modern and efficient acid plant and no more objectionable. It can be stated definitely that this process disposes of the nuisance created by pickle liquor and similar spent acids as well and efficiently as is practical. It is obvious that no plant can be built which does not in some way have minor drawbacks or where all effluents and nuisances are completely eliminated. When a nuisance problem is to be handled, one must always keep in mind the economics of the matter, to guide the engineer as to where to stop. It is unfortunate that in this country laws do not state in definite terms the exact amount of contaminations permissible in exit gases or effluent liquors as is the case, for example, in England where the type of acid plant used in this process is regularly operated within the limits of the definite law. If such were the case here, the engineer would have an easier task in solving problems of this nature.

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PROBABLY the best evidence of the merits of this process is the recent doubling of the Sayreville Plant, mentioned above, after several years operation. These operations showed conclusively that the acid could easily be produced at a cost below the market cost of fresh acid, with a satisfactory return on the capital investment. It is true that this method requires a high plant investment cost. However, when considering this investment, it is necessary to also consider the cost of other disposal and recovery methods. If these other methods require an investment cost without bringing any return, or still worse operate at a deficit, then the amount of any such deficit must be added to the possible profit with the "Chemico" plant, and this profit applied against the difference in investment costs of the two methods. When this is done, the "Chemico" Sulphate Conversion Process will usually be found to offer the more economical solution of any large scale pickle liquor disposal problem.

Some Characteristics Of Wire And Their Relation To Cold Heading

(*Continued from Page 528*)

may be able to meet the specifications, convenient conversion charts are necessary.

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THE relation of breaking load to ultimate tensile strength of a threaded article is subject to numerous variables. **Mr. E. M. Slaughter** (6) reported that tensile results obtained from calculations based on the root diameter are high and results based on the pitch diameter are low, as compared to the actual tensile strength of the material determined from a machined section. Results based on the mean diameter, taken as one half the sum of the root diameter plus the pitch diameter are only slightly low. The extent of this variation depends on such items as the screw thread pitch and diameter or size of the screw. Mean diameter however, is quite universally used today to make the calculation.

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LET us examine some tensile test results taken on random cap screws heat treated in production quantities. The bolts were pulled after segregating according to the diameter of Brinnell Hardness impressions taken on individual specimens. Test results plotted in Figure 9, show the effect of Brinnell Hardness on the breaking load of several sizes of commercial cap screws. The test pieces were taken from production lots over an extended period of time.

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THE curves include only those readings ranging from 3.7 to 4.4 MM diameter of impression, which corresponds to a Brinnell Hardness of 187 to 269. The usual hardness specification for SAE 1035 cap screws is 3.8 to 4.2 MM diameter of impression or a Brinnell Hardness of 207-255.

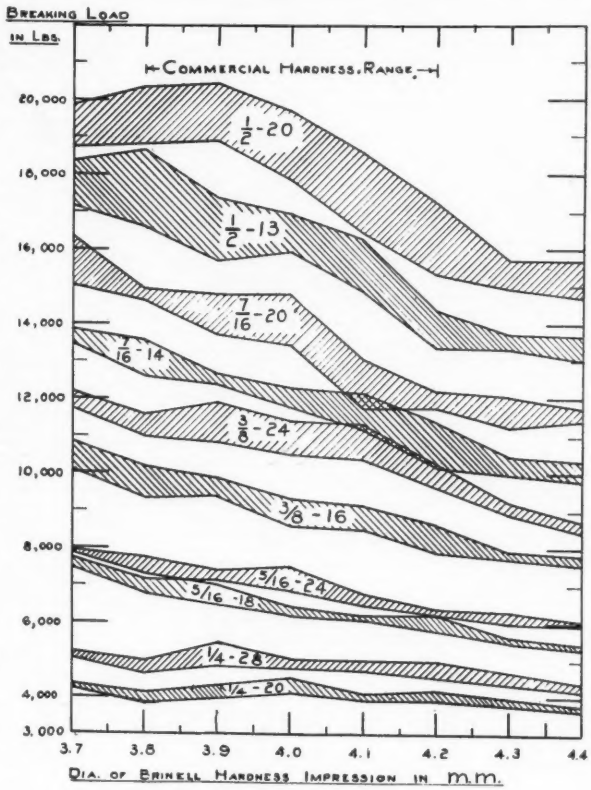

Figure 9. Breaking load limits for various sizes of commercial cap screws.

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CURVES similar to these are common in the hands of bolt producers. These are presented for the benefit of those not familiar with the properties of threaded articles. They should be of some help to Designing Engineers who desire information on production lots of cap screws.

✦ ✦ ✦

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A Series of Three Lectures Outlining the Fundamental Principles of Wire Mill Metallurgy Will Be Presented at the 1938 Wire Association Meeting at Detroit

THESE lectures will be in simple language, understandable by the non-metallurgist and will be presented as a part of the program of the Wire Association Meeting at Detroit, Michigan, October 17 to 21st inclusive.

By B. L. McCarthy,
Chief Metallurgist,
Wickwire Spencer Steel Co.,
Buffalo, N. Y.

Tentative titles are:
Part I—Principles of Metallurgy
Part II—Thermal Reactions
Part III—Metallurgy of Steel Wire

MEMBERS of the Wire Association will be entitled to attend these lectures without additional cost other than the regular registration fee for the meeting.

Exports and Imports of Wire

Exports of Iron and Steel Wire Products in July, 1938 and July, 1937
(In gross tons)

	JULY 1938	JUNE 1938	JULY 1937
Wire rods	1,312	3,392	3,775
Strip steel	2,712	5,043	8,411
Plain, black or galvanized iron or steel	5,667	4,455	7,575
Barbed wire and woven wire fencing	4,054	3,300	2,789
Woven wire screen cloth	93	112	219
Wire rope	204	336	599
Insulated iron or steel wire and cable—see analysis below			
Other wire and manufactures	539	489	774
Wire nails	2,264	1,547	1,760
Tacks	20	11	67
Other nails, including staples	555	424	173
Bolts, machine screws, nuts, rivets and washers	643	604	969
Total, these 11 classifications	18,063	19,713	27,111

Imports of Iron and Steel Wire Into the United States
(In gross tons)

Concrete reinforcement bars	89	52	95
Hollow bar and drill steel	47	9	146
Wire rods	278	327	1,045
Barbed wire	692	866	1,767
Round iron and steel wire	107	49	239
Telephone and telegraph wire	.....	.....	2
Flat wire and strip steel	168	154	281
Wire rope and strand	99	178	404
Other wire	97	160	380
Hoops and bands	1,040	1,806	3,584
Nails, tacks and staples	626	543	1,827
Bolts, nuts and rivets	12	21	94
Total, these 12 classifications	3,255	4,165	9,864

Exports of Insulated Wire and Cable, July, 1938

	Foreign		To U. S. Possessions	
	Pounds	Dollars	Pounds	Dollars
Rubber covered wire	435,136	$ 95,733	106,768	$ 23,430
Weatherproof wire	250,326	33,183	55,523	9,121
Other insulated copper wire	439,334	166,780	236,523	34,626
Nickel-chrome electric resistance wire	17,949	21,352	26	26
Total, these 4 classifications	1,142,745	$317,048	398,840	$ 67,203

Exports

FROM the standpoint of tonnage, steel ingot shipments in July ranked first with 17,862 tons. The bulk of this trade (13,500 tons) went to Japan, while Spain accounted for 3,904 tons. Next-ranking was plate (boiler, fabricated, and 'other') whose total of 17,390 tons went to mostly Kwantung, 4997 tons; Sweden, 2,271 tons; the Netherlands, 1,843 tons; Japan, 1,514 tons; and Canada, 1,451 tons.

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BLACK steel sheet shipments amounted to 14,730 tons and were taken by principally Canada, 2,854 tons; the Soviet Union, 2,742 tons; the United Kingdom, 1,941 tons; Australia, 1,184 tons; and Mexico, 1,127 tons. The tin plate total (fourth in importance) was 12,802 tons and, in this widespread trade, the most important markets were Canada, 2,755 tons; the Netherlands, 1,434 tons; Mexico, 918 tons; and the Philippine Islands, 906 tons.

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PIG iron exports amounted to 10,371 tons and went to chiefly Japan, 8,201 tons. Shape shipments totaled 8,171 tons and were taken by chiefly Canada, 3,168 tons; Venezuela, 1,345 tons; and Peru, 1,057 tons.

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EXPORTS of scrap in July totaled 126,423 tons valued at $1,667,487 in comparison with 162,066 tons valued at $2,231.681 in the preceding month and 425,303 tons valued at $8.834,079 in the like month of 1937.

JAPAN was the leading outlet in July, and accounted for 25,133 tons of mostly ingots, 13,518 tons; pig iron, 8,201 tons; plate, 1,514 tons; tin plate, 1,015 tons; and wire rods, 975 tons. Next came Canada with 17,695 tons of principally shapes, 3,168 tons; black steel sheets, 2,854 tons; tin plate, 2,755 tons; and plate, 1,451 tons. Following was the Philippine Islands taking 9,591 tons of chiefly galvanized steel sheets, 2,932 tons; steel bars, 2,915 tons; and tin plate, 906 tons. Kwantung's 6,847 tons ranked next, and the outstanding items were plate, 4,997 tons; car wheels and axles, 1,067 tons; and steel bars, 768 tons. Then came Venezuela's 6,001 tons of chiefly casing and oil-line pipe, 1,962 tons; shapes, 1,345 tons; and welded galvanized steel pipe, 341 tons. Brazil ranked sixth with 4,898 tons of mostly barbed wire, 1,306 tons; tin plate, 621 tons; black steel sheets, 566 tons; and galvanized sheets, 457 tons.

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Imports

IMPORTS of iron and steel products (excluding scrap) into the United States during July amounted to 14,094 gross tons valued at $955,215 in comparison with 15,573 tons valued at $1,035,536 in June and 41,188 tons valued at $2,084,401 in July, 1937.

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FOR the second time this year, the monthly import trade was valued at less than one million dollars, the only other month in which this has been the case over a number of years having been in March when the value was $990,379.

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FROM the standpoint of volume, the 4,125 tons of hoops and bands received was outstanding in the month's trade and came from chiefly Germany, 2,947 tons; and Belgium, 1,139 tons. Next-ranking, structural shapes (practically all 'plain') totaled 2,507 tons and came from mostly Belgium, 2.155 tons; and France, 254 tons. Following was ferromanganese with 1.309 tons taken from chiefly Norway, 616 tons; the Netherlands, 279 tons: and Czechoslovakia, 277 tons. Steel pipe was the

fourth-ranking item in the July trade, its total of 1,242 tons coming from principally Germany (970 tons). Then came steel bars with 973 tons taken from chiefly Belgium, 481 tons; and Germany, 169 tons. Pig iron followed with a 936 ton total and the principal sources were British India, 499 tons; and the Netherlands, 250 tons.

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GERMANY accounted for the highest tonnage in July, sending in 5,161 tons. The principal items in this trade were hoops and bands, 2,947 tons; steel pipe, 970 tons; nails, tacks, and staples, 384 tons; and barbed wire, 359 tons. Belgium followed with 4,620 tons of mostly shapes, 2,155 tons; hoops and bands, 1,139 tons; and steel bars, 481 tons. Sweden followed with 874 tons of chiefly wire rods, 240 tons; flat wire and steel strips, 152 tons; and steel bars, 133 tons. France was next with 664 tons of principally shapes, 254 tons; and steel bars, 159 tons.

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CARD CLOTHING receipts totaled 11,457 square feet valued at $20,195 against 11,521 square feet valued at $19,763 and came from the United Kingdom (9,693 square feet valued at $15,754; Belgium (1,328 square feet valued at $2,575 and Germany (436 square feet valued at $1,866).

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RECEIPTS of WIRE HEDDLES totaled nothing as against 153,000 pieces.

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A TRADE of 23,862 square feet resulted in WIRE CLOTH AND SCREEN against 42,392 square feet and came from Canada 7,094 square feet, Germany 6,737 square feet, Netherlands 3,849 square feet, and Japan 3,580 square feet.

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RECEIPTS of WIRE FENCING AND NETTING, galvanized before weaving amounted to nothing. Of that galvanized after weaving, the total was 1,848,910 square feet as against 1,637,150 square feet and came chiefly from Belgium, 1,847,270 square feet.

FOURDRINIER AND OTHER PAPER-MAKING WIRE imports at 29,343 square feet as against 19,450 square feet and were supplied principally by Germany 27,296 square feet, and France, 1,436 square feet.

✦ ✦ ✦

EXPORTS of iron and steel wood screws during July, 1938 totaled 8,956 gross valued at $2,009. Of this total Cuba took 2,348 gross valued at $384; Honduras 997 gross valued at $128; Canada 976 gross valued at $167; Colombia 700 gross valued at $149; Neth. West Indies 495 gross valued at $75; Venezuela 400 gross valued at $39.

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EXPORTS of brass wood screws during the same month totaled 4,355 gross valued at $1.942. Of this total Costa Rica took 789 gross valued at $348; Panama, C. Z. 700 gross valued at $286; Neth. West Indies 530 gross valued at $178; Cuba 497 gross valued at $176; Venezuela 422 gross valued at $217; United Kingdom 366 gross valued at $194.

✦ ✦ ✦

IMPORTS of wood screws during the same month totaled 3,500 gross valued at $277 supplied by Belgium.

This is an invitation for you to become a member of The Wire Association. ✦ ✦ ✦ ✦ ✦ ✦

The Annual Dues Are $10.00
AND INCLUDE

1. A subscription for the period of the membership to the designated official publication of the Association, "WIRE AND WIRE PRODUCTS."
2. A copy of the annual WIRE BUYERS GUIDE AND YEAR BOOK OF THE WIRE ASSOCIATION.
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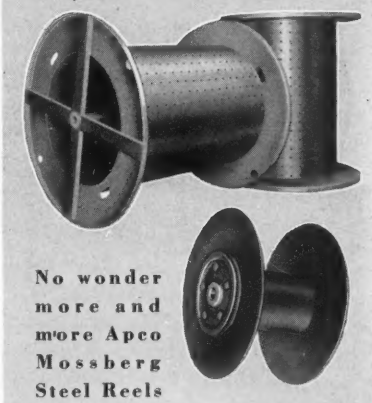

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Progress in the Wire Industry

By Frederick A. Westphal,

Superintendent of Wire Mills,
Sheffield Steel Corp., Kansas City, Mo.
President of The Wire Association

CONTINUED progress and versatility in the wire industry is and has been developing principally in seven directions, and operating men, engineers and metallurgists are constantly on the alert for continued betterment of finished products.

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THE first phase of this development is the metallurgical and metallographical research continuously being studied from all angles, which means striving and analyzing for better and more economical methods for making steel by taking into consideration what is charged at the Open Hearth furnaces and, furthermore, what has happened at each subsequent rolling operation, from the ingot to the finished rod. Likewise, the non-ferrous producers are constantly on the alert in a coinciding direction to attain a better quality of metal for the producing of their non-ferrous rods for wire.

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SECOND — Engineering developments for material handling systems are constantly being devised that tend for safety and efficiency of operation, with consequent saving in labor and costs. For instance, straight line cleaning combined with the use of acid resisting materials, that are impervious to chemical reaction from acid, for the construction of tanks has had a definite development for the past ten years, and has proven successful. This is only one of many improvements.

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THIRD — Machinery design is definitely established for continuous drawing for multiple drafting of ferrous (both high carbon and low carbon steel), non-ferrous and certain alloy wires. Speeds for finishing wire are still progressing without any sacrifice of quality, and with definite inherent savings in conversion costs. How far this leads to, we don't know yet!

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FOURTH — The development and successful research and attainments of Tungsten-Carbide dies, I believe, is the most important contribution for progress in machinery design and for faster speed of drawing. In addition finishes and physical properties of wire have progressed by the use of sintered carbide dies.

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FIFTH — Billet and Rod Mills are progressing in the development of rolling heavier weight billets and coils of rods, which mean increment loads and weights of single units for processing through Wire Mills are vastly larger. Material handling systems make this particular phase possible, but it will be temporarily "blocked out" until wire consumers become cognizant of the importance of heavier weight coils and subsequently install equipment for handling heavier weight coils of rods and wire that can be supplied them. Again, I reiterate that progress in the future may demand 2000# or 3000# continuous length coils of rods.

FREDERICK A. WESTPHAL
Superintendent of Wire Mills,
Sheffield Steel Corp., Kansas City, Mo.
President, The Wire Association

Born Holyoke, Mass., 1895. Graduate U. S. Naval Academy. Four years with American Steel & Wire Co. In 1922 Assistant Superintendent, Rod and Wire Works, Jones & Laughlin Steel Corp., Aliquippa, Pa. In 1928 Superintendent of Wire Mills, Sheffield Steel Corp., Kansas City, Mo. During World War served as Officer Sixth Field Artillery — severely wounded in action — twice cited and decorated for gallantry in action and meritorious services

✦ ✦ ✦

SIXTH — The essential operation of correctly baking rods and wire has had a most progressive step very recently in the development of "flash baking," that not only saves a tremendous lot of time in this operation, but this new type baker is easily installed in straight line cleaning, as well as in the old circular type layout for cleaning.

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SEVENTH—Electric welders for butt welding rods and wire at this time have donated to the wire industry a successful means for aiding the achievement of more efficient operations in drawing; also they have made possible the heavier weight coils of finished wire, with a consequent improvement in yields in processing through to finished wire products.

✦ ✦ ✦

TO mention seven directions is only part of this picture of the wire industry because practically every wire producer works out individual developments of a progressive nature from year to year, especially when some perplexing problem presents itself that calls for resourcefulness in attempting its solution.

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Superintendent, Wire Mills,
Sheffield Steel Corp.,
Kansas City, Mo.

Vice President
J. C. CALLAGHAN
Works Manager, Canada Works,
Steel Co. of Canada, Ltd.,
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THE Wire Association is a non-profit organization of wire mill executives, superintendents and foremen. It also includes plant engineers, traffic men, credit men, salesmen, and all others engaged in the wire industry, together with manufacturers, and other interested people who have something to sell to the wire mill or some service to render for pay.

✦ ✦ ✦

THERE are separate divisions for all the separate major interests in the wire industry, steel, iron, brass, copper, alloy, and precious metals, together with divisions relating to drawing, fabricating, forming, spring making, wire cloth, wire rope, insulated wire, electric wire and cable and all other forms of wire and wire products.

JOHN C. CALLAGHAN
Works Manager, Canada Works, Steel Co. of Canada. Vice-President, The Wire Association

ACTIVITIES:

ITS specific purpose is to improve production methods and afford a clearing house for ideas on management problems, technical problems, and research work in all phases of practical wire drawing and wire working, and to develop and maintain friendly relations among the members.

RALPH K. CLIFFORD
Works Manager, Continental Steel Corp. Past President, The Wire Association

✦ ✦ ✦

THE Association functions along the following lines:

1. The use of the Association headquarters as a central clearing house for information and data of all kinds which may be of interest to members.
2. The exchange of ideas on processes of production including machinery, technical processes, etc.
3. The establishment and maintenance of friendly relations among the members of the association and the development of sectional and national meetings to discuss matters of mutual interest.
4. Studies of production methods and analysis of production costs.
5. Developments in the use of new materials and new applications of existing materials and by-products.
6. Research and collection of information on personnel management, including such factors as labor turnover, seasonal changes, in the demand for employees, wage scales, etc.
7. Standardization and simplification as a means for the effective elimination of waste.
8. Such other subjects as may be determined upon.

E. W. CLARK
Mechanical Engineer, Wire and Cable Section, General Electric Co., Schnectady, N. Y., Vice President, The Wire Association

Every wire mill production executive engaged in the manufacture or fabrication of wire and wire products of any kind is invited to join the Wire Association and attend these meetings. ✦ ✦ ✦ ✦ ✦ ✦

RICHARD E. BROWN
Secretary, The Wire Association, Publisher, WIRE AND WIRE PRODUCTS.
Major Spec. Res., U.S.A.

In addition to a program of research papers, a splendid opportunity is offered for informal discussions. For this purpose Wire Association Headquarters in the Detroit-Leland Hotel are open from 9 A. M. to 11 P. M. daily. ✦ ✦ ✦ ✦ ✦ ✦

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RICHARD E. BROWN,
Secretary

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17 East 42nd St., New York, N. Y.

L. D. SEYMOUR
Chairman—Program Committee

Born August 12, 1902—Hornell, New York. Received B. S. in Metallurgy, Pennsylvania State College—1926. Until 1929 employed in the Physical Laboratory of American Steel and Wire Company, Worcester, Mass. Two years as Metallurgist with Reed & Prince Manufacturing Co. Four years with Jones & Laughlin Steel Corporation as Wire Metallurgist in their Aliquippa, Pa. plant. Metallurgist, Youngstown Sheet and Tube Company in 1934 to 1938. Now Metallurgist, Steel Company of Canada.

WILLIAM H. BASSETT, JR.
Chairman—Non-Ferrous Division
Program Committee.

Born December 25, 1896 at New Bedford, Mass. Attended Cheshire Academy, Cheshire, Conn. Graduated from M.I.T., 1918, Captain Ordnance Reserve, U.S.A. 1920-1929—American Brass Co.—Waterbury and Ansonia, Conn. 1929 to date—Anaconda Wire and Cable Co. From 1929-1936—Technical Supt. & Metallurgist. From 1937 to date—Manager, Metallurgical Development. Vice-Chairman of Committee B-1 of the A.S.T.M. On Executive Committe of A.I.M.E. Member of American Transit Association, A.I.E.E., American Society for Metals, The Wire Association. Licensed Professional Engineer in New York State.

✣ PROGRAM ✣

Monday, October 17, 1938 at Detroit-Leland Hotel, Detroit, Mich.

A. M.—Registration—"Get Together"

1 P. M. Directors' Meeting—Program Committee Meeting and Luncheon.

✦ ✦ ✦

The Technical Sessions

MONDAY, TUESDAY, WEDNESDAY AND THURSDAY, OCTOBER 17-18-19-20, 1938

(All Research Papers Will Be Preprinted in the October Issue of Wire and Wire Products.)

THERE WILL BE A REGISTRATION FEE OF $5.00 FOR THOSE ATTENDING THESE TECHNICAL SESSIONS AND INFORMAL MEETINGS

▲ ▲ ▲ ADMISSION WILL BE BY BADGE ONLY ▲ ▲ ▲

MONDAY, OCTOBER 17
Afternoon Sessions, 2:30 P. M.

STEEL DIVISION

Ralph K. Clifford, General Works Manager,
Continental Steel Co., Kokomo, Ind.
Chairman of Meeting

"Resilience of Spring Materials"	R. R. Tatnal, Engineer	Wickwire-Spencer Steel Co. Worcester, Mass.

Members of The Institute of Metals Division of the A. I. M. M. E. are invited to attend this session of the Non-Ferrous Division without payment of The Wire Association registration fee.

NON-FERROUS DIVISION

Wm. H. Bassett, Jr., Manager Metallurgical Development,
Anaconda Wire and Cable Corp.
Hastings-on-Hudson, N. Y.
Chairman of Meeting

"Notes on the Annealing of Copper Wire"	L. B. Barker, Testing Engineer	General Electric Co. Schenectady, N. Y.
Chromium Copper Alloy Wire	C. H. Davis Metallurgist	American Brass Co., Waterbury, Conn.
Motion Picture: Manufacture of Oil-Filled Cable.		General Electric Co., Schenectady, N. Y.

TUESDAY, OCTOBER 18
Morning Session, 9:30 A. M.

STEEL DIVISION

L. D. Granger, Treasurer
American Wire Fabrics Corp., New York, N. Y.
Chairman of Meeting

Lecture: "Principles of Metallurgy"	B. L. McCarthy, Metallurgist	Wickwire-Spencer Steel Co., Buffalo, N. Y.
"Wire Cloth, Its Many Kinds and Uses"	R. B. Roth, Purchasing Agent	Ludlow-Saylor Wire Co., St. Louis, Mo.

HONORABLE LOUIS JOHNSON,
The Assistant Secretary of War

Colonel Louis Johnson, the assistant Secretary of War, who will be the guest speaker at the Wire Association Luncheon at Detroit, Mich., October 19, 1938, was born in Roanoke, Virginia, January 10, 1891. Colonel Johnson is a graduate of the University of Virginia, Class of 1912, with the Degree of Bachelor of Law. A graduate of the Officers Training Camp, he was commissioned a Captain of Infantry in November, 1917 and assigned to the 80th Division.

In the Meuse-Argonne offensive he was in action with the 4th, 5th, 80th and 90th divisions and served with the American Army of Occupation in Germany. For his war services he received the Decoration of "Commandeur Order National de la Legion D'Honneur" from the French government.

In 1932 he was elected National Commander of The American Legion and he is a life member of the executive committee of that organization.

In 1933 he was elected American Vice President of the Federation Interalliè des Anciens Combattants, the international organization of World War Veterans popularly known as FIDAC.

Colonel Johnson served as Civilian Aide to the Secretary of War for the State of West Virginia from 1933 to 1937. He is a member of the Federal Advisory Council of the United States Employment Service, which functions under the Department of Labor. He was a delegate to the Democratic National Convention in 1924. At the Democratic National Convention in 1936 he presided at a meeting of war veteran delegates. Later he was made chairman of the Veterans Advisory Committee of the Democratic National Committee.

Colonel Johnson is a vestryman of Christ Episcopal Church, Clarksburg; a member of his local Masonic organizations; past Exalted Ruler of the Benevolent Protective Order of Elks; past President of Rotary; a member of the National Society, Sons of the American Revolution, of the Reserve Officers' Association of the United States, of the American Bar Association, West Virginia State Bar Association and the Associaton of the Bar of the City of New York.

He is a Lieutenant Colonel in the Infantry Reserve Corps, United States Army and was appointed Assistant Secretary of War by President Roosevelt on June 28, 1937.

Members of The Institute of Metals Division of the A. I. M. M. E. are invited to attend this session of the Non-Ferrous Division without payment of The Wire Association registration fee.

TUESDAY, OCTOBER 18
Afternoon Sessions, 2:00 P. M.

NON-FERROUS DIVISION

W. H. Eastlake, Asst. General Superintendent
Northern Electric Co., Montreal, Canada
Chairman of Meeting

"Heating Copper Wire Bars"	J. A. Doyle, Vice-President and Heating Engineer	W. S. Rockwell Co. New York City
"Aluminum-Coated Steel Wire"	Dr. Colin G. Fink Head Division of Electrochemistry	Columbia University, New York City
"The Development of High Strength Electrical Conductors and Messenger Cable"	C. H. Davis, Assistant Technical Director Ira T. Hook, Research Engineer	American Brass Company Waterbury, Conn.

STEEL DIVISION

M. H. Fromman, General Superintendent
The Townsend Co., New Brighton, Pa.
Chairman of Meeting

"Effect of Under Critical Annealing Treatments on Cold Drawn Steels"	F. C. Brandon, Metallurgist	Union Drawn Steel Div., Republic Steel Corp., Massillon, Ohio
"Some Characteristics of Wire and Their Relation to Cold Heading"	H. L. Hopkins, Metallurgist	National Screw & Mfg. Co., Cleveland, Ohio

WEDNESDAY, OCTOBER 19
Morning Session, 9:30 A. M.

GENERAL MEETING

E. H. Thomas, Superintendent
George W. Prentiss Co., Holyoke, Mass.
Chairman of Meeting

Lecture: "Thermal Reactions"	B. L. McCarthy, Metallurgist	Wickwire-Spencer Steel Co., Buffalo, N. Y.

Acid Disposal Symposium

Modern Pickle Liquor Recovery	Dr. N. Titlestad, Chemical Engineer, and S. F. Spangler, Chemical Engineer	Chemical Construction Corp. New York City
Disposal of Waste Pickle Liquor	Dr. Otto Mantius, Consulting Engineer	National Lead Co., (Acid Recovery Dept.) New York City
The Butler-Little Process	Julian M. Avery, Engineer	Arthur D. Little, Inc., New York, N. Y.

WEDNESDAY, 1:00 P. M.
Wire Association Luncheon

Guest Speaker—Hon. Louis Johnson, The Assistant Secretary of War.

(Members are at liberty to invite guests to hear this interesting speaker talk on a topic of national interest pertinent to the Wire Industry—Members and guests of other societies participating in the National Metal Congress are also invited to attend.) The address of Colonel Johnson will be broadcast over the Columbia Network.

WEDNESDAY, OCTOBER 19
Afternoon Session, 4:00 P. M.

F. A. Westphal, Superintendent Wire Mills,
Sheffield Steel Co., Kansas City, Mo.
Chairman of Meeting

▲ ▲ ▲ ▲ Wire Association Annual Meeting ▲ ▲ ▲ ▲

WEDNESDAY, OCTOBER 19
Evening—The Detroit-Leland Hotel—7:00 P. M.
Annual Dinner—Stag-Smoker

DINNER COMMITTEE

R. L. Hamaker, Dist. Sales Manager
Warner Company
New York, N. Y.
Chairman

A. R. Zapp, Manager
Firthaloy Division
Firth Sterling Steel Co.
McKeesport, Pa.

THURSDAY, OCTOBER 20
Morning Session, 9:45 A. M.

STEEL DIVISION

Dr. S. A. Braley, Senior Industrial Fellow
Mellon Institute of Industrial Research
Pittsburgh, Pa.
Chairman of Meeting

Lecture: "Metallurgy of Steel Wire"	B. L. McCarthy, Metallurgist	Wickwire-Spencer Steel Co., Buffalo, N. Y.
"Stainless Steel Wire"	J. K. Findley Metallurgist	Ludlum Steel Co., Dunkirk, N. Y.

THURSDAY, OCTOBER 20
Afternoon Session, 2:00 P. M.

STEEL DIVISION

M. G. Ensinger, President, and General Manager
Union Wire Rope Corp., Kansas City, Mo.
Chairman of Meeting

"Rope Wire"	W. R. Bloxdorf, Metallurgist	MacWhyte Co., Kenosha, Wis.
"The Kind and Necessity of Tests for Rope Wire"	H. K. Hammerstein, Chief Engineer	Broderick & Bascom Rope Co., St. Louis, Mo.

STENOGRAPHIC PROCEEDINGS

STENOGRAPHIC minutes of the discussions at the Wire Association meetings held at Detroit, Michigan, October 17 to 21, 1938, inclusive, will be published in full in regular issues of WIRE & WIRE PRODUCTS following the meeting.

✦ ✦ ✦

MEMBERS of the Wire Association and subscribers to WIRE & WIRE PRODUCTS will receive these proceedings in this manner.

✦ ✦ ✦

OTHERS desiring the proceedings can obtain them either by becoming members of the Wire Association, or by subscribing to WIRE & WIRE PRODUCTS.

Make Your Plans Now To Attend The National Metal Congress and The Wire Association Technical Sessions — All Engaged In The Production, Fabrication and Sale of Wire and Wire Products Are Invited.

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AKIN, W. M., Vice President,
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Arcade Bldg., St. Louis, Mo.

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Prescot, Lancashire, England.

ALKINS, WM. E., Manager of Research Dept.,
Thomas Bolton & Sons, Ltd.,
Oakamoor, Stoke-on-Trent
Staffordshire, England

ANDZULIS, JOSEPH M., Foreman,
The Bridgeport Screw Co.,
Bridgeport, Conn.

ANJESKEY, A. F., Sales Mgr.,
Cleveland Tramrail Div. of the
Cleveland Crane & Eng. Co.,
Wickliffe, Ohio.

ATKINSON, L., Superintendent,
Frost Steel & Wire Co., Ltd.,
250 Lottridge St., Hamilton,
Ontario, Canada.

BABB, C. W., Factory Supt.,
The Columbus Bolt Works Co.,
291 N. Water St., Columbus, Ohio.

BAKER, DAVID, JR., Metallurgical Eng.,
1011 Chestnut Street,
Philadelphia, Pa.

BARNINGHAM, CHAS. S., Sales Mgr.,
New England Butt Co.,
304 Pearl St., Providence, R. I.

BARTLETT, J. C., Proprietor,
Bartlett Hair Spring Wire Co.,
North Haven, Conn.

BASSETT, CYRUS W., Engineer,
Elevator Supplies Co., Inc.,
Rahway, N. J.

BASSETT, WM. H., JR., Manager,
Metallurgical Development,
Anaconda Wire and Cable Co.,
Hastings-on-Hudson, N. Y.

BEACH, HAROLD K., Engineer,
Phelps Dodge Copper Products Corp.,
American Copper Products Div.,
Elizabeth, N. J.

BEAMAN, P. ALDEN, Sales Mgr.,
Wire Machinery Dept.,
Morgan Construction Co.,
15 Belmont St., Worcester, Mass.

BEARDSLEE, K. R., General Sales Mgr.,
Carboloy Company, Inc.,
2985 E. Jefferson Ave., Detroit, Mich.

BEESON, J. K., Asst. Manager of Sales
Pittsburgh Steel Co.,
Grant Bldg., Pittsburgh, Pa.

BEIGHLEY, ANSON E., Sales Repr.,
American Chemical Paint Co.,
2025 Mars Ave., Cleveland, Ohio.

BEKAERT, L. A., Managing Director,
S. A. Trefileries Leon Bekaert,
Sweveghem, Belgium.

BENNETT, H. W., President,
Belleville Wire Rope Co.,
691 Main St., Belleville, N. J.

BEVERIDGE, N. G., Mgr. Wire Works Dept.,
Union Steel Corporation, (S.A.) Ltd.,
P. O. Box 48, Vereeniging,
Transvaal, South Africa.

BLACK, WINTON S., Joint Manag. Dir.,
Speedwell Wire Co. Ltd.,
Speedwell Works, Coatbridge, Scotland.

BLOUNT, HARRY, Development Engineer,
Western Electric Co., 2500 Broening
Highway, Baltimore, Md.

BLOUNT, WM. H., President & General Mgr.,
Sleeper & Hartley, Inc.,
Worcester, Mass.

BLOXDORF, WALTER R., Metallurgist,
Macwhyte Co., Kenosha, Wis.

BOGMAN, MAJOR JAMES H. BEALS,
Signal Corps., U. S. Army,
Office of the Chief Signal Officer,
Munitions Bldg., Washington, D. C.

BOLL, JOHN K., Manager, Wire Sales Div.,
Wheeling Steel Corp.,
Wheeling, West Va.

BOND, FRANK A., Vice-Pres.,
The McKay Company, 1005 Liberty Ave.,
Pittsburgh, Pa.

BOSWIN, GEO. A., Gen. Sales Mgr.,
Cable Reel Dept.,
Stevens Metal Products Co.,
Niles, Ohio.

BOULIN, VICTOR J., Manager,
Vianney Wire Die Works,
250 E. 43rd St., New York, N. Y.

BRALEY, S. A., Senior Industrial Fellow,
Mellon Institute of Industrial Research,
4400 5th Ave., Pittsburgh, Pa.

BRIGHTMAN, H. M., Asst. to President,
Columbia Steel & Shafting Co.,
Carnegie, Pa.

BROADDUS, E. T., Representative,
Firth-Sterling Steel Co.,
710 W. Lake St., Chicago, Ill.

BRODEN, EDWIN H., Mgr., Wire Mills,
American Steel & Wire Co.,
826 Frick Bldg., Pittsburgh, Pa.

BRODEN, G. A., President,
Broden Construction Co.,
11730 Harvard Ave., Cleveland, Ohio.

BRONSON, W. D., Sales Representative,
Carboloy Co., Inc.,
565 W. Washington St., Chicago, Ill.

BROTEN, O. A., Vice President,
National Pneumatic Co.,
McCormick Bldg., Chicago, Ill.

BROWN, HUGH E., Director of Research,
The W. S. Tyler Company,
3615 Superior Ave., Cleveland, Ohio.

BROWN, RICHARD E., Publisher,
WIRE & WIRE PRODUCTS,
17 East 42nd St., New York, N. Y.

BRUNTON, J. D., President,
Bruntons (Musselburgh), Ltd.,
Musselburgh, Scotland.

BRYANT, F. H., Secretary,
The Western Automatic Machine Screw Co.,
Elyria, Ohio.

BUCHANAN, D. D., Asst. Gen. Mgr.,
Union Drawn Steel Div.,
Republic Steel Corp.,
Harsh Ave., Massillon, Ohio.

BULLOCK, CAPTAIN FRANK W.,
Signal Corps., U. S. Army,
Office of the Assistant Secretary of War,
Washington, D. C.

BUSH, MAJOR GEO. P.,
Signal Corp., U. S. Army,
1st Ave. & 58th St., Brooklyn, N. Y.

BUTLER, J. F., Supt.,
Milton Mfg. Co.,
Milton, Pa.

BUTLER, VICTOR H., Metallurgist,
Baxters (Bolts, Screws & Rivets), Ltd.,
Parade Works, Birmingham, England.

(Please turn to Page 606)

Welcome To The

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By a Member of The Wire Association.

— 1934 —

EDWARD J. P. FISHER

Metallurgist, Keystone Steel & Wire Co., Peoria, Ill.

Title of Paper: "COLD DRAWN STEEL SPRING WIRE"

— 1935 —

BENJAMIN LEWIS McCARTHY

Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.

Title of Paper: "GRAIN SIZE AND ITS INFLUENCE ON THE MANUFACTURE OF STEEL WIRE"

— 1936 —

ROBERT NOTVEST

Chief Engineer, Welding Division, J. D. Adams Mfg. Co., Indianapolis, Ind.

Title of Paper: "STEEL FOR ARC WELDING ELECTRODES"

— 1937 —

BENJAMIN LEWIS McCARTHY

Chief Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.

Title of Paper: "ABNORMAL GRAIN GROWTH AND THE ANNEALING OF LOW CARBON STEEL WIRE"

HONORABLE MENTIONS

— 1935 —

L. D. SEYMOUR

Metallurgist, Rod and Wire Dept., Youngstown Sheet & Tube Co., Youngstown, O.

Title of Paper: "COLD HEADING WIRE"

R. A. SCHATZEL

Superintendent, General Research Laboratories, General Cable Corp., Rome, N. Y.

Title of Paper: "HARD AND SOFT COPPER WIRE"

— 1936 —

BENJAMIN LEWIS McCARTHY

Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.

Title of Paper: "PLASTIC DEFORMATION IN WIRE DRAWING"

— 1937 —

ROBERT W. SANDELIN

Metallurgist, Atlantic Steel Co., Atlanta, Ga.

Title of Paper: "A METALLURGICAL STUDY OF THE FACTORS AFFECTING THE QUALITY OF GALVANIZING"

ALLAN B. DOVE

Chemical Engineer, Canada Works,
The Steel Company of Canada, Ltd., Hamilton, Ont., Canada.

Title of Paper: "A. C. ELECTRO PICKLING—A BETTER METHOD OF PICKLING"

Wire Association Membership List — 1938

(Continued from Page 605)

CALLAGHAN, JOHN C., Works Mgr.,
Canada Works, Steel Co. of Canada, Ltd., Wellington St. N., Hamilton, Ontario, Canada.

CARNAHAN, H. B., Asst. Works Mgr.,
Canada Wire & Cable Co., Ltd., Box 340, Toronto, Ont., Canada.

CARTER, BEN, Managing Director,
B. & F. Carter & Co., Ltd., Albion Works, Waterloo St., Bolton, Lancs., England.

CASEY, AUSTIN, Sales Engineer,
Syncro Machine Company, 187 Sylvan Ave., Newark, N. J.

CASSIDY, LEVI M.,
Wickwire Spencer Steel Co., Station B, Buffalo, N. Y.

CHAMBRE, LOUIS, Vice-President,
Balloffet Dies & Nozzle Co., Inc., 45-47 Adams St., Guttenburg, N. J.

CHATTERTON, E. R., Treasurer,
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CLARK, E. W., Mechanical Engineer,
Wire & Cable Section, General Electric Co., Schenectady, N. Y.

CLARK, HERBERT B., Vice-President,
Union Wire Die Corp., 375 Fairfield Ave., Stamford, Conn.

CLIFFORD, RALPH K., Gen. Works Mgr.,
Continental Steel Corp., Kokomo, Indiana.

COCHRAN, ISAAC GEORGE, Supt. Wire Mill,
Laclede Steel Co., Alton, Illinois,

CONNOR, F. J., Dist. Manager,
Wickwire Spencer Steel Company, Worcester, Mass.

COOCH, LOUIS S., Metallurgist,
Buffalo Bolt Company, North Tonawanda, N. Y.

COPPICK, JOHN C., Manager,
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CORBLEY, EDWARD F., Superintendent,
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CREWE, L. C., JR., Foreman Wire Mill,
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CROSSET, D. A., Treas. & Gen. Mgr.,
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DENNIS, M .W., JR., Die Engr.,
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DENNIS, WALTER J., Die Sales Engineer,
Vascoloy-Ramet Corp., North Chicago, Ill.

DERN, EMIL, Secretary,
Kelly Wire Die Corp., 19 West 34th St., New York, N. Y.

DIMLING, PAUL ELMER, Firthaloy, Rep.,
Firth-Sterling Steel Co., McKeesport, Pa.

DOMES, VIKTOR, Wire Engineer,
Felten & Guilleaume A. G., Bruck A/D Mur, Austria.

DONALD, GEO. E., Superintendent,
Donald Ropes & Wire Cloth Co., Hamilton, Ontario, Canada.

(Please turn to Page 607)

Wire Association Membership List — 1938

DONOVAN, GORDON I., Supt.,
Volco Wire Co., Inc.,
Kenilworth, N. J.
DOVE, ALLAN B., Chem, Engr.,
Steel Co. of Canada, Ltd.,
Montreal, Canada.
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4400 W. National Ave., Milwaukee, Wis.
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Globe Wire Die Co.,
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DRIVER, ROBERT O., Vice-President,
Wilbur B. Driver Company,
150 Riverside Ave., Newark, N. J.
DUNKELBERGER, L. E., Chief Engineer,
Reynolds Wire Co.,
85 Crawford Ave., Dixon, Ill.
EARLY, E. F., Superintendent,
Wickwire Spencer Steel Co.,
Morgan Works, Worcester, Mass.
EASTLAKE, WM. H., Asst. Gen. Supt.,
Northern Electric Co., Ltd.,
Montreal, P. Q., Canada.
EATON, R. M., Resident Manager,
Hazard Insulated Wire Works,
70-74 Hazle St., Wilkes-Barre, Pa.
EDICK, H. L., Plant Superintendent,
Wickwire Brothers,
189 S. Main St., Cortland, N. Y.
ELDER, FLINT C., Chief Metallurgist,
American Steel & Wire Company,
Rockefeller Bldg., Cleveland, Ohio.
ELIAS, H. W., Asst. Mgr., Firthaloy Div.,
Firth Sterling Steel Co.,
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Pittsburgh Steel Co., Monessen, Pa.
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Charge of Research and Development,
Oliver Iron & Steel Corp.,
1001 Muriel St., Pittsburgh, Pa.
FAST, PAUL R., Plant Superintendent,
Belden Manufacturing Co.,
4647 W. Van Buren St., Chicago, Ill.
FIRTH, F., Managing Director,
Overend & Co., Ltd., Mount Tabor Works,
Leeds, 9, Yorks., England.
FIRTH, L. GERALD, President & Gen. Mgr.,
Firth-Sterling Steel Co.,
McKeesport, Pa.
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Tube Mill & Cold Drawn Div.,
Aetna-Standard Eng. Co.,
Youngstown, Ohio.
FOSBURG, HILDOR A., Secretary,
The Meaker Co.,
1629 S. 55th Ave., Chicago, Ill.
FOSS, DR. ING. FEODORE F.,
Assistant to Chairman & Gen. Metallurgist,
Wheeling Steel Corp.,
Wheeling, W. Va.
FRASER, J. C., Gen. Mgr.,
Laidlaw Bale Tie & Wire Co., Ltd.,
Hamilton, Ontario, Canada.
FRASER, JOHN G., Mgr.,
The Northern Bolt, Screw & Wire Co., Ltd.,
Owen Sound, Ontario, Canada.
FRIEDMAN, J. H., Vice-President,
National Machinery Co.,
Tiffin, Ohio.
GAINES, FREDERICK W., 3d, Mech. Eng.
Ajax Manufacturing Co.,
Chardon Road, Euclid, Ohio.
GIRVEN, J. E., Wire & Cable Engineer,
Canadian General Electric Co., Ltd.,
Peterborough, Ontario, Canada.
GLADER, FRANK J., President,
Wm. Glader Machine Works,
210 N. Racine Ave., Chicago, Ill.
GORDON, C. S., Wire Development Eng.,
Bell Telephone Laboratories, Inc.,
463 West St., New York, N. Y.
GOULD, WM., Mechanical Engineer,
80 Van Cortlandt Park South,
New York, N. Y.
GRANGER, L. D., Asst. to Vice-Pres.,
Wickwire Spencer Steel Co.,
41 E. 42nd St., New York, N. Y.
GRASSELL, P. W., Pres. & Treasurer,
Wilson Steel & Wire Company,
4840 S. Western Ave., Chicago, Ill.
GUNDSTROM, E. W., Asst. Plant Mgr.,
Rome Cable Corp., Rome, N. Y.
GUSCOTT, LOWELL E., Superintendent,
United Screw & Bolt Corp.,
3590 W. 58th St., Cleveland, Ohio.

(Please turn to Page 608)

Wild wire spreads upward. Wire straightened-in-coil is without this tendency and will tend to straighten in the plane of the bundle when freed.

One of the most frequently occurring and troublesome defects of wire and one that is often unrecognized, is improper cast (wild wire). Properly killed round wire may be spread in coils (see illustration above) without any of the loops showing a tendency to rise from the horizontal plane. With proper cast wire, the spring maker can produce his finished products of uniform diameter and length. Wire fabricators find that cut lengths of crimped wires will lie flat, wire forms are true to shape . . . cast makes the difference between easy and hard working wire. In the Wickwire Spencer Mills cast is recognized as an important physical property. Every care is exercised that the dies are kept in alignment with drawing blocks. Thus the primary cause of improper cast is eliminated.

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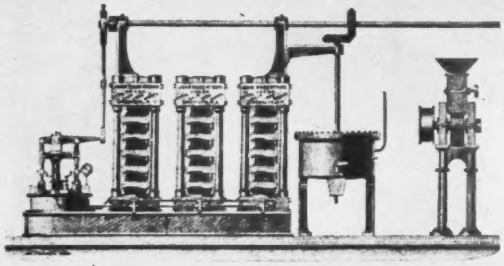

The above engraving represents a set of three Hydraulic Presses, a set of Pressure Pumps, a Heater and Crusher Rolls. Each press has a very strong Cast Iron head and base, connected by four forged Iron columns, a powerful Cylinder, Copper lined, with 12 in. Ram and five Cake boxes.

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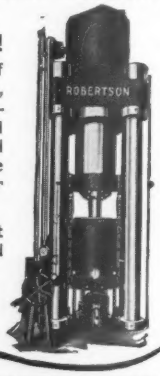
Get the facts . . . they're yours without obligation. A note on your letterhead brings them all!



JOHN ROBERTSON COMPANY, INC.

125-137 WATER STREET, BROOKLYN, N.Y.

Wire Association Membership List — 1938

(Continued from Page 607)

HAGNER, RANDALL, Research Laboratory, Owens-Illinois, Glass Co., Industrial & Structural Products Laboratory, Newark, Ohio.

HAGUE, JOSEPH A. Dist. Sales Mgr., Pittsburgh Steel Company, Union Trust Bldg., Cleveland, Ohio.

HAKA, JOHN E., Works Manager, Midland Wire Corp., 70 Hunter St., Tiffin, Ohio.

HAMAKER, R. L., Dist. Sales Manager, Warner Company, 122 E. 42nd St., New York, N. Y.

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(Continued from Page 608)

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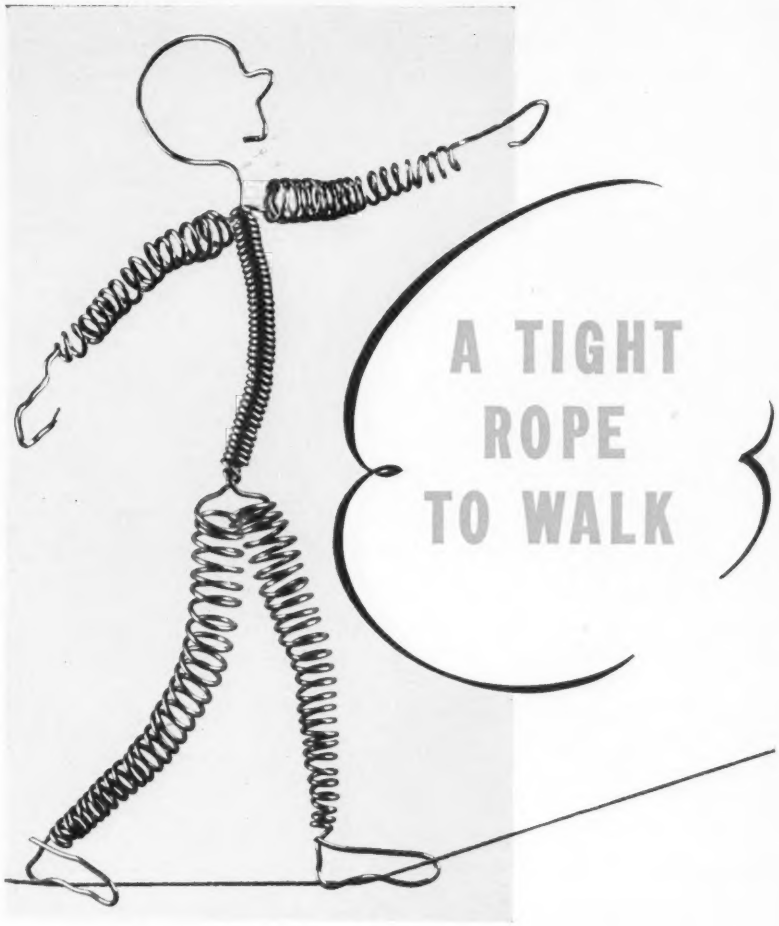

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THE paper entitled "Development of High Strength Electrical Conductors and Messenger Cable," by C. H. Davis, Assistant Technical Director, and Ira T. Hook, Research Engineer of the American Brass Company, Waterbury, Connecticut, will be published in full in the November issue of WIRE & WIRE PRODUCTS.

✦ ✦ ✦

THE address of Colonel Louis Johnson, Assistant Secretary of War, will also be published in the November issue, together with the details of the Convention and the technical sessions.

✦ ✦ ✦

THE series of lectures delivered by Mr. B. L. McCarthy, Metallurgist, Wickwire Spencer Steel Company, Buffalo, New York, before the Wire Association, will be published in full in monthly issues of WIRE & WIRE PRODUCTS following the meeting.

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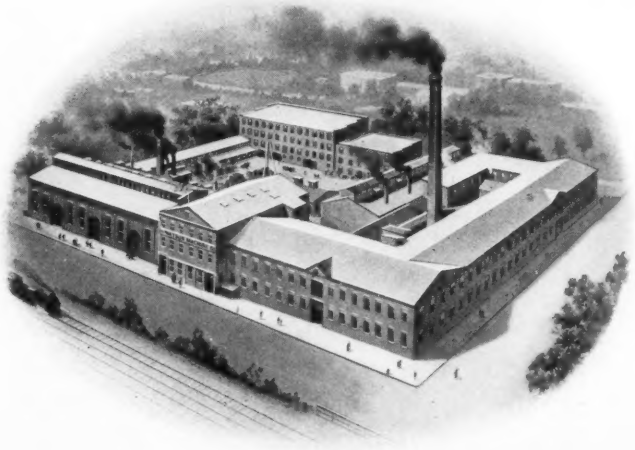

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American Insulating Machinery Co.,
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WOOD, MAURICE L.,
Chase Brass & Copper Co., Inc.,
Waterbury, Conn.
WOODFORD, F. M., Western Manager,
Tungsten Electric Corp.,
3030 Euclid Ave., Cleveland, Ohio.
WOODHEAD, R. R., Research Engineer,
John A. Manning Paper Co., Inc.,
Troy, N. Y.
WOODSON, C. C., Superintendent,
Beall Tool Co.,
East Alton, Ill.
YORT, A. O., Superintendent,
Wire & Tack Mill, Republic Steel Corp.,
Grand Crossing Works,
South Chicago, Ill.
YOUNG, LAFE, General Superintendent,
Laclede Steel Co., Alton, Ill.
ZAPP, A. R., Manager, Firthaloy Div.,
Firth-Sterling Steel Company,
McKeesport, Pa.
ZARAFU, HERMAN, Plant Engineer,
Circle Wire & Cable Co.,
5500 Maspeth Ave., Maspeth, L. I., N. Y.
ZOUCK, JOHN, Chief Inspector,
Bethlehem Steel Co.,
Sparrows Point, Md.

✦ ✦ ✦

British Steel Men Cancel October Visit

THE visit of the members of the British Iron and Steel Institute and the British Institute of Metals to the United States, which was scheduled for October, has been cancelled because of unsettled political conditions in Europe.

✦ ✦ ✦

WHETHER the visit will be reconsidered at a later date in the event of the present political crisis solving itself, is not yet known.

✦ ✦ ✦

PLANT tours and inspection trips at the several iron and steel centers had been arranged, and the party was to include all the leading executives of the iron and steel and nonferrous metal industries of Great Britain.

✦ ✦ ✦

THE Wire Association had extended an open invitation to the members of the participating societies to attend the Wire Association meetings on a guest basis, and it is regretted that our English friends will be unable to avail themselves of this invitation.

To Those Registering and Attending
The Wire Association Meetings
THERE WILL BE A
REGISTRATION FEE OF $5.00
Admission will be by Badge Only

THE paper entitled "Development of High Strength Electrical Conductors and Messenger Cable", by C. H. Davis, Assistant Technical Director, and Ira T. Hook, Research Engineer of the American Brass Company, Waterbury, Connecticut, will be published in full in the November issue of WIRE & WIRE PRODUCTS.

✦ ✦ ✦

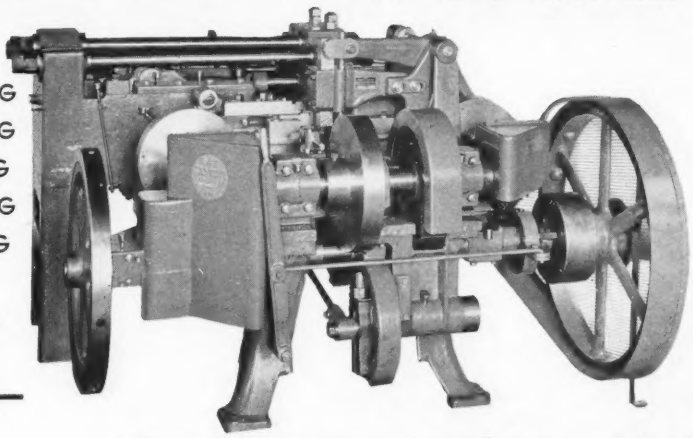
THE address of Colonel Louis Johnson, Assistant Secretary of War, will also be published in the November issue, together with the details of the Convention and the technical sessions.

✦ ✦ ✦

THE series of lectures delivered by Mr. B. L. McCarthy, Metallurgist, Wickwire Spencer Steel Company, Buffalo, New York, before the Wire Association, will be published in full in monthly issues of WIRE & WIRE PRODUCTS following the meeting.

NILSON AUTOMATIC PRESS AND FOUR SLIDE MACHINE

FOR SWAGING STAMPING PIERCING BLANKING FORMING OF COILED METAL



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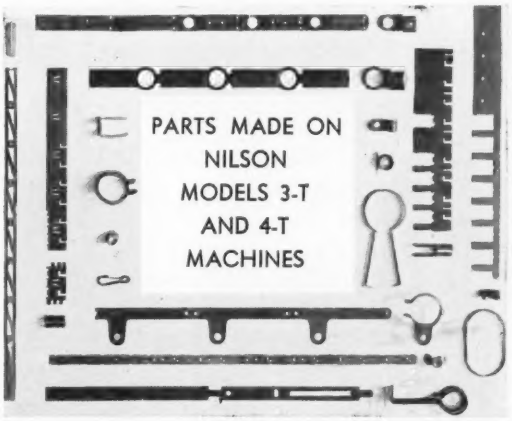

▲▲▲

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Resilience of Springs

(*Continued from Page 550*)

Conclusion

THE facts and data presented in this paper provide a knowledge of the meaning of resilience and a background for the analysis of any particular material or problem. It is not a matter of research so much as a correlation and comparison of technical data, and an exposition of the relative utility of various types of wire applications in spring problems. While rather technical in some of its aspects, the same technicalities are involved in many wire failures, and a clear understanding of the background given here may well help in determining the correct application of a wire, or in the development of a wire for some troublesome application.

✦ ✦ ✦

Reduction of Acid Fumes

ACID fumes, long the bane of all wire cloth manufacturers and others operating pickling tanks, may soon pass to the limbo of the horse and buggy days. Four manufacturers of steel wire cloth of York and Hanover, Pa., employ a new gas process for cleaning or oil removal (after weaving) before electrogalvanizing. Using small gas-fired ovens with heat traveling counterflow to the wire cloth, they are successfully cleaning steel wire cloth 30 to 48 inches wide, of 12 to 16 mesh. The cloth passes over rollers for three horizontal passes in the oven; an air seal is created in the vertical feed and delivery legs of the oven. Temperature control is set for 750 deg F. with a gas consumption of .62 therm per hour (56 cu. ft. 1100 B.T.U. gas) or 100 cu. ft. 525 B.T.U. gas.

✦ ✦ ✦

THE wire, after heating, is a uniform dark purple color and is passed directly into the plating tank after passing through a stream of air to remove any dust remaining on the wire Not only does this system replace one or two caustic tanks, a water rinse tank, a muriatic acid, and another water rinse tank, but it eliminates the injurious fumes and avoids expensive maintenance and upkeep. The old-fashioned equipment required control of the acidity of the tanks and constant repairs to them as they were destroyed by the action of the acid.

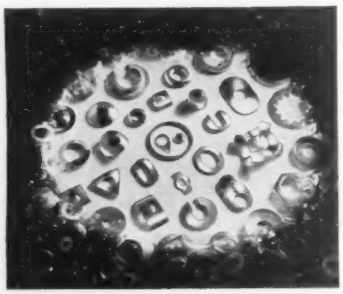
✦ ✦ ✦

Williams Robb Barclay

WILLIAMS ROBB BARCLAY, authority on science and the technique of non-ferrous metallurgy, died at Birmingham, recently at the age of 62.

✦ ✦ ✦

HE was best known for his contribution to the development of the nickel industry in which he held an executive position. Mr. Barclay was prevented by illness from delivering the Calvin W. Rice Lecture before the American Society of Mechanical Engineers in June, 1938, and accepting a D.S.C. degree from Stevens Institute of Technology.



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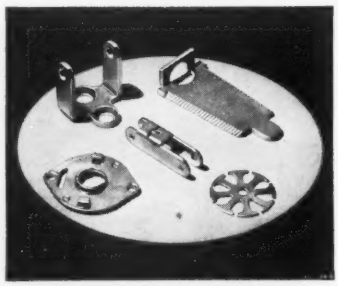
for producing washers and stampings used in the production and assembly of almost every type of manufactured product made today.

We maintain our own fully equipped Tool and Die Shop—enabling us to promptly make up new specifications to individual order.

SPECIAL NOTE

We carry in stock a complete size range of washers for wire and cable reel bolts —round, square, malleable iron, etc.

Send us a size list or blue prints of your washer and stamping needs for our prompt quotation. Our money-saving estimates should prove interesting to you.



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MILWAUKEE WROT WASHERS

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'Round the World With the Wire Industry

German Notes

FROM August 21st to 24th the 26th East German Fair will take place at Konigsberg, together with the East German Fair of the Federation of Agricultural Associations. Among the novelties exhibited at this fair will be a new fencing system for cattle which substitutes barbed wire with a new oval steel wire. The latter weighs only half as much as barbed wire and on the other hand has a considerably higher tensile and breaking strength. Another advantage of this material is that the erection presents no difficulty at all, as it is delivered as finished chain link fencing.

✦ ✦ ✦

THE general improvement on the wire export market continues, although the turnovers show considerably smaller figures than same time last year. The improvement is in wire and fencing wire whereas barbed wire is still neglected. Prices are unaltered. Wire rods are well maintained at 5. 2. 6., although the extension of the international wire rod cartel was provisionally possible only up to September 15th (the cartel will however again be extended). The best purchasers of all are South Africa, the Straits, the Balkan markets and the African Colonies, whereas the trade with the Near East is very dull and the Latin American markets buy but irregularly. India is reappearing on the market. Mandschukuo is buying thin wires and ropes, the Balkans manufacturing wires, ropes and nettings. The North European markets are quiet and the export business in netting has not participated in the general improvement.

✦ ✦ ✦

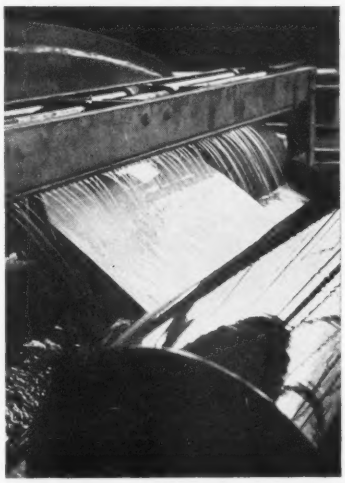
THE export of wire ropes and strand wire from Germany shows the following figures for the first half of this year: the total export was 8,029 tons compared with 9,658 tons same time last year. Of this quantity Great Britain bought 412 tons (462 tons 1937), Italy 761 tons (631 t) the Netherlands 534 tons (835 t in 1937), Sweden 223 tons (322 tons 1937), 237 tons (106 t) were exported to Turkey, 173 t to Russia (406 t), 213 t (420 t) to China and 254 tons to British India. The Dutch Indies took 387 tons (330 t 1937), the U. S. A. 66 t (882 t), Argentine 324 t (356 t), Brazil 575 t (399) and Chile 299 tons (compared with 206 t 1937).

✦ ✦ ✦

THE wire rod cartel is able to maintain the export quotation

(*Please turn to Page 616*)

BASOLIT *Protected* **PICKLING TANKS**



THE above picture shows one of eight tanks of a double line continuous pickler recently installed in one of the large steel plants in Cleveland. Each line consists of four 60 ft. pickling tanks and two rinse tanks, designed to handle up to 106 inch strip—one of the widest sheet picklers in the country.

The tanks are of rubber lined steel. As a protection for the rubber lining our well known construction of a double sheathing of acid-brick and BASOLIT was used.

Including the tanks, all acid floors and sewers were brick-lined with BASOLIT joints.

The installation illustrated is one of many hundreds where BASOLIT has contributed toward long life and efficient operation of modern pickling equipment.

NUKEM PRODUCTS CORP.

66 Niagara St., Buffalo, N. Y.

New York Pittsburgh Detroit Kitchener, Ont.

'Round the World With the Wire Industry

(*Continued from Page 615*)

of £ (gold) 5. 2. 6—5. 5. 0. Competition is negligible. American wire rods are not offered at prices below the aforesaid quotation. Although the extension of the wire rod cartel has been possible only for the period of another month (September), there is no actual danger of a collapse of the association.

✦ ✦ ✦

PRODUCTION and consumption of nail-screws (for fastening sheet metal to wood, etc.) shows an improvement. A specially hardened quality is at present demanded by customers. On the export market Latin America buys little of this article, whereas all other countries buy well. In Germany this article is produced by a small number of manufacturers only but one factory sells nearly 75% of the output for export. The sizes chiefly bought are 1½" to 3".

BUSINESS in ship nails, which are mainly supplied by Sweden and Norway, is quiet, as these nails, with rose heads, are suffering from the competition of ordinary steel nails, bought nowadays by many small yards ovresea, which are cheaper than the rough-surface-plate-cut Scandinavian nails. Prices are slowly receding and are at present in the neighborhood of £ (gold) 8.10.

✦ ✦ ✦

British Output Falls To Low Level

THE output of iron and steel in the United Kingdom during July fell to its lowest level in 3 years, it is stated in a report from the office of the American Commercial Attache, London. Pig iron output amounted to 507,800 tons (the lowest figure since February, 1937) and recorded a decline of 6 percent from the June figure and of 30 percent from the total for July, 1937. The steel ingot total at 683,200 tons compared with 776,-100 in June and 1,059,200 in July, 1937. The lower output figures were ascribed partly to a seasonal movement expected to continue through August.

✦ ✦ ✦

IN the initial 7-month period of 1938, the cumulative figure for pig iron output was 4,513,200 tons in comparison with 4,740,300 in the like period of last year. The steel ingot and casting total of 6,609,700 tons compared with 7,397,000.

✦ ✦ ✦

Price Factor in United Kingdom

THE office of the American Commercial Attache, London, also writes that "prices represent an important element in the (iron and steel) situation," of the United Kingdom. Consumers are stated to be "holding off" from purchasing in the belief that "prices must come down." On the other hand, producers are refusing to meet any demand for price reduction. Officially, the members of the British Iron and Steel Federation are not scheduled to meet to discuss price changes until the close of 1938, but some sources are of the opinion that such a meeting will be held prior to the close of September.

We produce GOOD INHIBITORS exclusively.

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"NEP" is Used Successfully in Cleaning the Largest Tonnage of Rods and Wire Produced in the World. . . .

We Have Repeatedly Shown the Lowest Costs Ever Produced By Any Inhibitor.

More Companies in the United States, Canada, and Europe Are Using Our Products Than At Any Time in Our "25" Years Successful Developement of Inhibitors.

Low Costs Per Ton::: Good Finish::: Prompt Service::: "25" years attending to Our Own Business Has Produced a Large List of Satisfied Customers.

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We Can Reduce Your Inhibitor Costs (50%) Per Month
We Have Proven This In Many Plants

THE WM. M. PARKIN COMPANY

Chemical Engineers to the Steel Industry

Pittsburgh : Chicago : Detroit : Hamilton, Ont. : San Francisco : Birmingham : Warren, Ohio

Higher British Imports January-July, 1938

ALTHOUGH the iron and steel import trade of the United Kingdom fell sharply in July and indicated a slowing down, receipts in the initial 7 months of the current year totaled 1,059,396 tons in comparison with 823,354 in the corresponding period of 1937. The slackening in this trade (since July) is attributed partly to an accumulation of local stocks, coupled with a lessening in demand; however, the affect of the "steel duties" for the protection of the local industry may also have been partly responsible for the downward movement.

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

WIRE & WIRE PRODUCTS
17 East 42nd Street
New York City

The Butler-Little Process

AS a part of the Acid Disposal Symposium at the Wire Association Convention to be held at Detroit, October 17-21, a description of the Butler-Little process illustrated by lantern slides will be given in the form of an informal talk by Julian M. Avery of Arthur D. Little, Inc., New York, N. Y.

✦ ✦ ✦

R. W. Sandelin

R. W. Sandelin, metallurgist of the Atlantic Steel Company, Atlanta, Ga., who received honorary mention at the 1937 Wire Association Convention for his paper "A Metallurgical Study of the Factors Affecting the Quality of Galvanizing", has just been given leave of absence by the Atlantic Steel Company to attend the University of Minnesota to complete the work required to obtain his doctorate degree in metallurgy and metallography.

Rope Wire

(*Continued from Page 515*)

fore the true significance of fatigue values as ordinarily determined becomes apparent. The subject of rope wire fatigue is by no means simple and offers a fruitful field for future research.

✦ ✦ ✦

IN concluding, it is desired to leave the thought that the greatest problem of rope wire manufacture is to produce a wire of such quality and characteristics that adapt it perfectly to the service it is called upon to perform. In an effort to improve either process or product, innumerable questions arise pertaining to almost all phases of wire treatment and fabrication. Some of these questions are readily answered, while others require a certain amount of investigation. Despite the fact that much experimental work has been done on the manufacture of rope wire, it is difficult to name a single phase of it which would not profit by and which does not present problems for research.

We suggest you tell us about your problems concerning the quality of copper
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OFHC
OXYGEN FREE HIGH CONDUCTIVITY
A Superior Copper
FOR ALL PURPOSES
OFHC Copper conforms to the A.S.T.M. Specification for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.
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Syncro Machine Co., Wire Division of Elevator Supplies Co., Inc.

ANNOUNCEMENT is made of the amalgamation of the Elevator Supplies Company and the Syncro Machine Company, by Arthur M. Meeker, Vice-President of the Elevator Supplies Company, Inc.

✦ ✦ ✦

THE new organization will operate under the name and style of the Syncro Machine Company Wire Division of the Elevator Supplies Company, Inc., and will include in its operations the manufacture and sale of all machines of every type pertaining to the wire and wire products industry.

✦ ✦ ✦

THE operating and sales personnel will remain as at present, with headquarters in New York City at 420 Lexington Avenue.

✦ ✦ ✦

THE purpose of the consolidation is to more effectively serve the wire industry, the consolidation serving as it does to place the facilities of two well-known existing organizations under one control and thus give more effective service to its customers.

ARTHUR M. MEEKER
Vice President
Elevator Supplies Co., Inc.

MAKE YOUR PLANS NOW TO COME TO THE WIRE ASSOCIATION MEETING

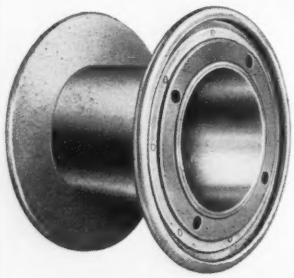
This in an invitation for you to become a member of The Wire Association. ✦ ✦ ✦ ✦ ✦ ✦

The Annual Dues Are $10.00
AND INCLUDE

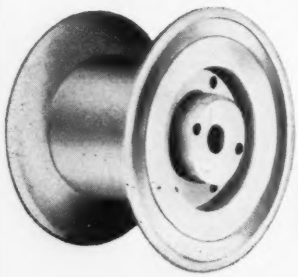
1. A subscription for the period of the membership to the designated official publication of the Association, "WIRE AND WIRE PRODUCTS."
2. A copy of the annual WIRE BUYERS GUIDE AND YEAR BOOK OF THE WIRE ASSOCIATION.
3. A copy of the proceedings and discussions held at the annual meeting.
4. Co-operative and helpful information on processes and methods of production.

For Details Address

Richard E. Brown, Secretary,
The Wire Association
17 E. 42nd St., New York, N. Y.



FINE WIRE HIGH SPEED WIRE DRAWING SPOOLS



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Announces a complete line of HEAVY DUTY PRECISION SPOOLS and REELS especially designed for high speed wire drawing and annealing.

The degree of efficiency obtained by the HIGH SPEED WIRE DRAWING MACHINE is largely dependent upon the accuracy and durability of the take-up spool.

The use of our PRECISION SPOOLS will increase your machine efficiency and eliminate your spool difficulties.

Complete range of sizes.

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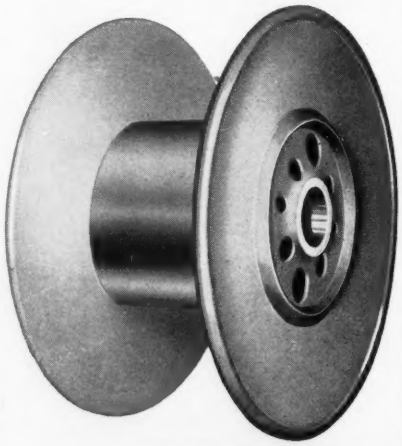


COMBINATION
500 lb. CAPACITY WIRE DRAWING — ANNEALING — STRANDING — REEL.

A Review of Recent Wire Patents

Patent No. 2,125,519, SEAT SPRING COVER ANCHOR, Patented August 2, 1938 by John M. Oldham, Pleasant Ridge, Mich., assignor to L. A. Young, Detroit, Mich.

Provided in the base frame of the spring structure is a perimetrical recess into which the seat cover is folded and held in place by a distortable clip that cannot ordinarily come out unless it is forced out by a suitable tool.

✦ ✦ ✦

Patent No. 2,125,583, WIRE FABRIC, Patented August 2, 1938 by William Edgar Reed, Pittsburgh, Pa.

Continuously extending strands, or sets of strands may be employed to provide a fabric of the welded type, in a continuous operation, and having desired differences in mesh spacing, structural characteristics and rigidity between various portions thereof. The strands, or sets of strands may extend at multiple angles with respect to each other as well as in the usual right angle directions of longitudinal strands and transverse stays. The fabric may be composed of a plurality of plies throughout, or only in certain areas.

✦ ✦ ✦

Patent No. 2,125,621, PADDED SPRING-CUSHION, Patented August 2, 1938 by Oliver M. Burton, Chicago, Ill., assignor to Burton-Dixie Corporation, Chicago, Ill., a corporation of Delaware.

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 17 East 42nd St., New York.

Applied directly to the spring assembly is a layer of cotton batting, on the outside of which is a layer of sisal, over which is placed a layer of padding, such as cotton batting or curled hair. The intermediate layer of sisal is secured to the innermost layer of cotton, prior to their application to the spring assembly by passing through a machine having reciprocatory barbed needles, which needle the sisal fibres together in rows, and also project the fibres into or through the underlying cotton-batting layer.

✦ ✦ ✦

Patent No. 2,125,717, WIRE FABRIC AND METHOD OF MAKING THE SAME, Patented August 2, 1938 by Raymond J. Guba, Philadelphia, Pa., assignor to Audubon Wire Cloth Corporation, Philadelphia, Pa., a corporation of N. J.

Conveyor belts having great flexibility, high tensile strength and flat smooth surfaces may be formed of alternately arranged right and left hand helically twisted wires maintained in desired relationship by cross rods engaging the bights of the several wires. Pairs of wires of right hand twist are arranged in alternation with pairs of wires of left hand twist, with the spirals of the wires of each pair passing through each other and lying in the same plane.

✦ ✦ ✦

No. 2,125,824, WIND-UP FOR WIRE CLOTH LOOMS, Patented August 2, 1938 by Herbert L. Thompson, Elgin, Ill., assignor to Reynolds Wire Co., Dixon, Ill., a corporation of Illinois.

The mechanism includes parts arranged to receive the woven cloth from the loom, impose necessary tension thereon, and wind the same in a roll on a mandrel. A pressure roll and a weight roll automatically move away from the mandrel in accordance with the growing size of the wire cloth roll thereon.

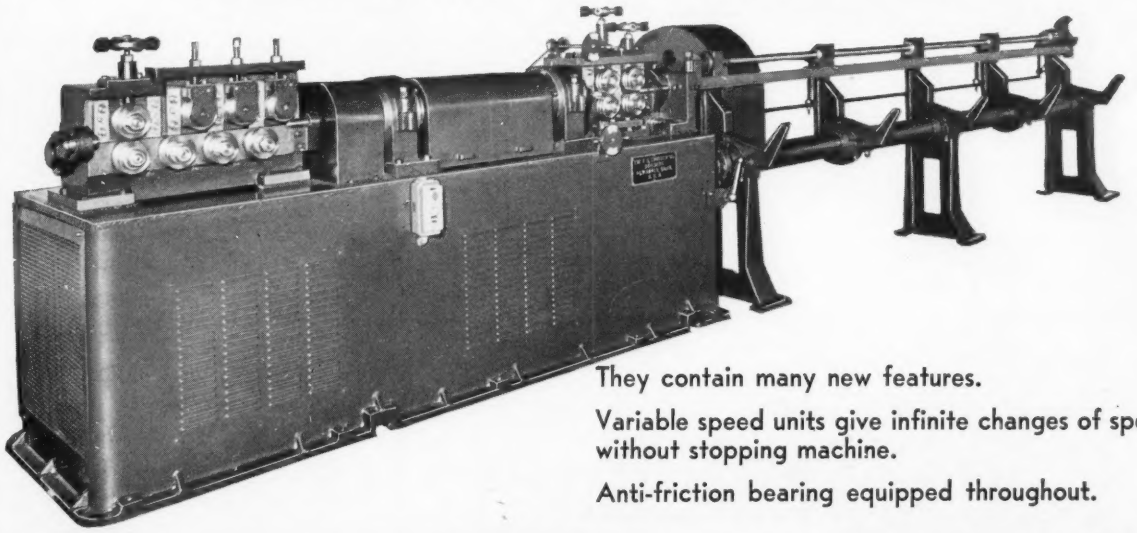
✦ ✦ ✦

No. 2,125,836, CONDUCTOR COVERING, METHOD AND COMPOUND FOR TREATMENT THEREOF, Patented August 2, 1938 by John W. Olson, Dobbs Ferry, N. Y., assignor to Anaconda Wire & Cable Company, New York, N. Y., a corporation of Delaware.

Encircling the conductor wire is a coating of rubber insulation, a jacket of fabric treated in a bath of stearin pitch,

(Please turn to Page 620)

SPEED UP PRODUCTION BY USING
SHUSTER DUAL CONTROL AUTOMATIC WIRES
STRAIGHTENING AND CUTTING MACHINE



They contain many new features.

Variable speed units give infinite changes of speed without stopping machine.

Anti-friction bearing equipped throughout.

THE F. B. SHUSTER COMPANY, New Haven, Conn.

Straightener Specialists Since 1866

(Continued from Page 619)

Montan wax, asphalt and graphite, and an over coat including the just mentioned materials plus carbon black and slate dust. The object is to avoid low-melting point waxes such as paraffin.

✦ ✦ ✦

No. 2,125,869, ELECTRICAL CONDUCTOR, Patented August 9, 1938 by Ralph W. Atkinson, Perth Amboy, N. J., assignor to General Cable Corporation, New York, N. Y., a corporation of N. J.

In order to reduce the skin effect in large alternating current conductors, a plurality of conducting segments are cabled together, each segment comprising a stranded conductor, and an electrostatic shield encloses the assembled segments and is electrically connected thereto adjacent the outer surface of the conductor.

✦ ✦ ✦

No. 2,126,069, ELECTRIC CABLE, Patented August 9, 1938 by Kurt Wanske, Berlin-Lichtenrade, Germany, assignor to Norddeutsche Kabelwerks Aktiengesellschaft, Berlin - Neukolln, Germany.

The conductor is held concentrically to an external helically wound covering tape having openings placed at longitudinal intervals and forming therebetween transverse webs carrying the threads which support the conductor. In another embodiment, the function of the slots is assumed by longitudinal recesses along the edge of the tape.

✦ ✦ ✦

No. 2,126,453, APPARATUS FOR FORMING BLANKS FROM HOT ROLLED WIRE STOCK, Patented August 9, 1938 by William W. Criley and Frederick W. Gaines, 3rd, Cleveland, Ohio.

The invention relates to apparatus for drawing to gauge, straightening and cutting to proper length, the wire or rod stock, during continuous travel through the apparatus, the wire blanks being removed from the path of the oncoming wire.

✦ ✦ ✦

No. 2,126,528, APPARATUS FOR CONTINUOUS WIRE DRAWING, Patented August 9, 1938 by Harold K. Beach, Cranford, N. J., assignor to Phelps Dodge Copper Products Corporation, New York, N. Y., a corporation of Delaware.

The mechanism provides for easy removal of a finished coil of wire without interrupting the progress of wire or stopping the wire drawing machine, the speed of coiling being limited only by the characteristics of the metal being drawn and the durability of the dies.

✦ ✦ ✦

No. 2,126,955, FLEXIBLE CONDUIT, Patented August 16, 1938 by George A. Gleason, Worcester, Mass., assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey.

Of a type used to carry the operating cables of automobile brakes, this conduit consists of a short-pitched helical coil of half-round wire having its normally flat side inside and upset so it is appreciably convex, T-wire wound over this coil with its stem portion forced inwardly between the convolutions of the half-round wire, and wires tightly wound with a long-pitched lay over the head portions of the T-wire.

✦ ✦ ✦

No. 2.126,977, CRADLE ADJUSTMENT FOR STRANDING MACHINES, Patented August 16, 1938 by David S. Robbins, Worcester, Mass., and Albert C. Uihlein, New Haven, Conn., assignors to The American Steel and Wire Company of New Jersey, a corporation of N. J.

In stranding machines of the planetary type, various kinds of wire rope spinning may be performed on the same machine, through the provision of an adjustable support permitting various positions of the cradles relative to each other.

✦ ✦ ✦

No. 2,126,979, MACHINE FOR MAKING SPRING MATTRESSES AND THE LIKE, Patented August 16, 1938 by Paul Sappington, Los Angeles, Calif., assignor of one-half to J. C. Rosenthal, Los Angeles, Calif.

Forming a mattress of rows of cushioning springs joined by connecting springs, the machine includes a structure supporting parallel rows of the cushioning springs, a carriage on the supporting structure, means rotating a connecting spring including a motor, and reverse gearing between the motor and the spring gripping means.

SCHUMAG

CONTINUOUS
ROD MAKING MACHINES

Produce directly from the hot rolled or extruded coil material in a single, evenly continuous operation and with one operator, perfectly straight and highly polished ferrous and non-ferrous rods or bars; round, square, hexagon and flat. Capacities 1/16—1 inch.

STRAIGHTENING AND POLISHING MACHINES

Straighten and highly polish:

Round Rods

Turned or Ground Shafting

Ground Drill Rods

CALOW

CENTRELESS BAR TURNING MACHINES

For turning down black rolled or forged round bars or billets, at high speeds and to very close limits of accuracy. Capacities 5/8—8 inch.

Write for particulars

W. A. SCHUYLER
Fisk Building

NEW YORK, N. Y.

No. 2,127,122, ELECTRIC CABLE, Patented August 16, 1938 by William F. Lamela, East Paterson, N. J., assignor to The Okonite Company, Passaic, N. J., a corporation of N. J.

A plurality of separately insulated cable conductors are assembled with asbestos rovings saturated with flame-retarding material to produce a core, which is taped and sheathed with non-inflammable rubber-like substance produced by dissolving a polymerized vinyl-halide at an elevated temperature in a non-volatile organic solvent.

✦ ✦ ✦

No. 2,127,306, WIRE DRAWING MACHINE, Patented August 16, 1938 by Walther Nacken, Gruna, Germany.

In the type of drawing machine having drawing rollers mounted on horizontal shafts and which perform the wire drawing operation entirely in the drawing solution, one or more intermediate chambers are provided between the place of passage of the drawing roller shaft through the wall of the gear casing and the place of entrance of the shaft into the liquid container, so that all drawing liquid entering the intermediate chamber will be carried away into the supply-container.

✦ ✦ ✦

No. 2,127,358, WIRE FABRIC AND METHOD OF MAKING THE SAME, Patented August 16, 1938 by Raymond J. Guba, Philadelphia, Pa., assignor to Audubon Wire Cloth Corporation, Philadelphia, Pa., a corporation of N. J.

A belt fabric is made up of pairs of wires in unit formation, each unit comprising a pair of helically coiled wires and a cross connector rod longitudinally of the helically coiled wires and transversely of the facric, the cross rods lying in the bights of the interconnecting helices of the respective coiled wires of each unit pair.

✦ ✦ ✦

No. 2,127,936, WIRE WINDING APPARATUS, Patented August 23, 1938 by Robert C. Pierce, Niles, Mich., assignor to National Standard Company, Niles, Mich., a corporation of Michigan.

A swift from which the wire is unwound, according to one desirable arrangement, is provided with a presser ring, resting on top of the wire on the swift, the wire being maintained under uniform tension and in a manner to prevent tangling.

✦ ✦ ✦

No. 2,127,989, WIRE-DRAWING MACHINE, Patented August 23, 1938 by Charles Arnold Barron and Herbert Douglas Barron, Preston, England.

The drawing is effected by traversing a die-holder about a stationary receiving drum, a plurality of dies being employed so that at each rotation of the die holder, the wire is drawn two or more times, the drawing operation being truly continuous.

✦ ✦ ✦

No. 2,128,410, MULTICONDUCTOR SIGNALING CABLE, Patented August 30, 1938 by Arthur G. Hall, Cranford, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York.

A plurality of individually insulated conductor units, such as paper insulated pairs or quads, is formed into a cable in which the interference effects between conductor units is reduced, the conductor units being in a plurality of layers, with the units of certain layers stranded with a zig-zag lay relative to the conductors in adjacent layers.

✦ ✦ ✦

No. 2,128,437, APPARATUS FOR AND METHOD OF PRODUCING SPLIT WIRE RINGS, Patented August 30, 1938 by Alfred Stenwall, Kewanee, Ill., assignor to Walworth Patents Inc., Boston, Mass., a corporation of Mass.

When formed of fusible material, the product is adapted for insertion in grooved pipe fittings. The wire is helically coiled upon a mandrel which is supported by a member provided with means to confine the coil in close engagement with the mandrel, and is adapted to expose a longitudinal strip of the coil for splitting into individual rings.

✦ ✦ ✦

No. 2,128,443, METHOD OF PRODUCING WIRE STAPLES, Patented August 30, 1938 by Max Vogel, Frankfort-on-the-Main, Germany.

It is proposed to form staple strips by first winding a wire into a helix with rectangular convolutions thereof forming the crowns and side legs of two

(Please turn to Page 622)

STANDARD OR SPECIAL DESIGN MACHINES AND EQUIPMENT

FOR

WIRE, ROD OR STRIP MILL

Strip Coilers — Cold Rolling Equipment — Rod Coilers

Galvanizing and Tinning Equipment — Scrap Bundling Machines

Wire Drawing Machines - - Continuous and for Fine Wire

Cotter Pin, Edging, Straightening and Cutting Machines

Cleaning and Pickling Equipment — Pointers — Swagers — Wire Frames

Wire Puller Tongs

High Grade Equipment at Present Day Prices — Your Inquiries Invited

BRODEN CONSTRUCTION CO.

ENGINEERS - - BUILDERS

Wire Mill and Cold Rolling Equipment

11730 Harvard Avenue — CLEVELAND

A Review of Recent Wire Patents

(Continued from Page 621)

strips of staples, next adhering the convolutions of the helix, and then cutting two opposed sides of the helix.

✦ ✦ ✦

No. 2,128,547, MULTIPLE CONDUCTOR WIRE ROPE, Patented August 30, 1938 by Walter T. Wells, Glendale, Calif., assignor, by mesne assignments, to Lane-Wells Company, Los Angeles, Calif., a corporation of Delaware.

A hoisting and conducting cable is provided wherein the multiple segmental conductor core is protected from the hydrostatic pressure and corrosive action of the various liquids that may be present in a well, by a yieldable insulative covering between the core and the weight supporting helical multi-stranded wire rope structure.

✦ ✦ ✦

No. 2,128,566, SPRING ASSEMBLY FOR MATTRESSES AND UPHOLSTERY, Patented August 30, 1938 by Lionel Selby Wallis, Tyseley, Birmingham, England.

The end coils of adjacent springs are connected together by fitting a depending curled loop or coil on a connecting wire over the adjacent parts of the spring coils and locking the connection by passing another wire or a cord, hook or other means through the loop below the spring coils.

✦ ✦ ✦

No. 2,128,677, DRAWING OF GALVANIZED WIRE, Patented August 30, 1938 by Frank Jenks, Port Waratah, Newcastle, New South Wales, Australia, assignor to Rylands Brothers (Australia) Limited, Port Waratah, Newcastle, New South Wales, Australia, a corporation of New South Wales.

Dry or plastic lubricants are applied to the wire in the drafts preceding the final draft, and then a fluid is applied having a solvent or softening action on the surface film of discolored lubricant which has adhered to the wire in the preceding lubricating drafts, so as to secure the removal of the film in the final drawing.

✦ ✦ ✦

No. 2,128,777, MACHINE FOR PRODUCING WIRE STRANDS, Patented August 30, 1938 by Philip Vassar Hunter, London, and Harry Hill, Belvedere, Kent, England, assignors to Callender's Cable and Construction Company Limited, London, England, a British company.

For the manufacture of non-circular pre-spiralled strand, there is provided a stranding head having two roll dies each comprising a pair of power-driven rolls, the rolls of the second die following closely the rolls of the first die and acting upon the strand in a direction transverse to that in which the rolls of the first die act.

✦ ✦ ✦

Adolph Bregman

ADOLPH BREGMAN, Metallurgical Engineer, since 1919 Managing Editor of Metal Industry, has severed his connection with that journal as of October 1st and established an office at 123 William Street, New York as a consultant in the metal products manufacturing and metal finishing industries. He will specialize on industrial problems, development of products and industrial markets, a field in which he has been engaged for a number of years. He has been Executive Secretary of the Masters' Electro-Plating Association of New York since 1934 and will retain that position.

✦ ✦ ✦

MR. BREGMAN is the author of a number of technical and industrial articles. He is a member of the Institute of Metals Division, A. I. M. E. and the American Society for Testing Metals.

✦ ✦ ✦

H. R. Larson

MR. HERMAN R. LARSON has been appointed Central District Service Manager, Westinghouse Electric & Manufacturing Company with headquarters at the Homewood Works. The announcement was made by Mr. H. F. Boe, Manager, Service Department.

700 NAILS PER MINUTE

GLADER BRAD AND FINE NAIL MAKING MACHINE

This machine will produce nails and brads ¼" to 1⅛" in length from wire 22 gauge to 16 gauge inclusive.

The Glader machine is made in eleven different sizes. This enables us to cover any size of nail most efficiently.

For prices and further information address,

Wm. Glader Machine Works

210 No. Racine Ave.,

CHICAGO, ILLINOIS.

Outstanding Personalities of the Wire Industry

M. G. ENSINGER
President and General Manager
Union Wire Rope Corp.
Kansas City, Mo.
Chairman—Wire Rope Session
Wire Association—Oct. 20.

From 1915 to 1922 was engaged in the oil industry as Tool Pusher, Salesman, and as Purchasing Agent and Field Superintendent successively. In 1923 went with American Cable Company in charge of Oil Country sales and in 1927 entered the employ of the Union Wire Rope Corp. of Kansas City, Mo. as Vice-President and General Superintendent; then became Vice-President and General Manager, and from 1935 to date President and General Manager.

✦ ✦ ✦

H. G. Danielson

MR. H. G. DANIELSON who has had twenty years of experience in oven and heating equipment has joined the sales staff of the Industrial Oven Division of the American Machine & Foundry Co. at New Haven, Conn.

✦ ✦ ✦

T. Kennedy Stevenson, President, Electrical Research Products, Inc.

T. KENNEDY STEVENSON has been elected president and a director of Electrical Research Products, Inc., a subsidiary of Western Electric Company. He succeeds the late Whitford Drake, who died August 24th.

✦ ✦ ✦

MR. STEVENSON has been associated with Western Electric Company for 24 years. For the last ten years he has been comptroller of manufacture of Western Electric.

Vincent W. Allen

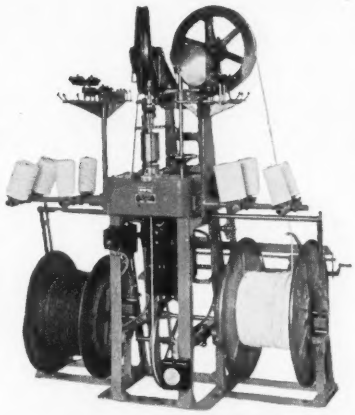
VINCENT W. ALLEN, assistant works manager of the Bridgeport Brass Co., Waterbury, Conn., died August 25 in that city. Following his graduation from Massachusetts Institute of Technology, Mr. Allen was employed by the American Brass Co. as master mechanic at the plant at Torrington, Conn., and in 1923 was made chief engineer of the company's Canadian mill at New Toronto. In 1927 he became works manager of the Michigan Copper & Brass Inc., and after this company merged with the Revere Copper & Brass

(*Please turn to Page 624*)

SINFRA

A New Machine For the Application of All Grades of Cotton, Rayon, Silk and Fibre Glass Coverings To Wire and Cable ✦ ✦ ✦

The Sinfranizing Process Covers Ordinary No. 14 AWG Rubber Covered Code Wire At A Speed of 1500 Feet Per Hour. Wire Sizes From #22 To #6 Can Also Be Accommodated. ✦ ✦ ✦



Single Head Machine
✦ ✦ Model C-1 ✦ ✦

Introducing the Knitting Method Into the Wire Covering Field and Offering Wire Producers Many Savings. ✦ ✦ ✦

The Sinfra cover is a new patented development consisting of interwoven knitted stitches. The spiralling of these stitches gives extraordinary results on burst tests.

Machines at plants of Phelps-Dodge Copper Products Corp., Anaconda Wire & Cable Co., U. S. Rubber Products Inc., Simplex Wire & Cable Co., and others.

For Details Ask For Bulletin

SINFRA CORPORATION

One Exchange Place — Jersey City, N. J.

Midwestern Agent—Albert R. Breen, 80 E. Jackson Blvd., Chicago, Ill.

Outstanding Personalities of the Wire Industry

(*Continued from Page 623*)

Co., was general manufacturing manager of all its mills. He joined the Bridgeport Brass Co. in 1932.

✦ ✦ ✦

John R. Freeman, Jr.

THE appointment of John R. Freeman, Jr., as technical manager of the American Brass Co., succeeding the late Herbert C. Jennison, has been announced.

Dr. Alan Morris

ALAN MORRIS, formerly research engineer, has been promoted to the position of chief metallurgist of the Bridgeport Brass Co. He will be in charge of the Physical and Chemical Laboratories as well as research activities.

✦ ✦ ✦

DR. MORRIS has been with the company since 1923 and has been actively engaged in the laboratory and mills developing new and better alloys and improving the standard ones.

BOTH his Bachelor of Science and his Metallurgical Engineering Degrees were received from Columbia University, and Yale recently awarded him a Doctor of Engineering Degree.

✦ ✦ ✦

Changes in Staff of Indiana Steel & Wire Co.

ANNOUNCEMENT of recent appointments to the executive sales staff of Indiana Steel & Wire Company, Muncie, Indiana, has been made by Fred M. Crapo, vice-president and general manager.

✦ ✦ ✦

R. J. McCabe

R. J. McCABE, for 30 years with Western Electric Company and Graybar Electric Company, has been named manager of sales, electrical materials. Mr. McCabe will direct the sale of the company's telephone and telegraph wire, steel conductors, steel strand and other products to the public utility field.

✦ ✦ ✦

James L. Galbraith

JAMES L. GALBRAITH, who has served as assistant sales manager for the past 12 years, now is manager of sales for manufacturer's wire and merchant trade products. Mr. Galbraith is widely known in the manufacturing and hardware trades having devoted the major portion of his time in the interest of materials and products applicable to these channels.

✦ ✦ ✦

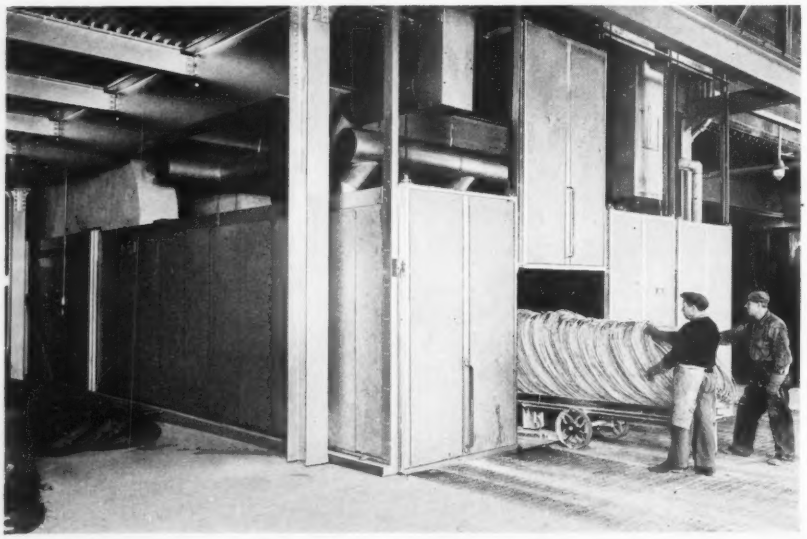
P. G. Gullett

P. G. GULLETT, assistant sales manager, who has been connected with the Indiana Steel & Wire Company for more than 35 years, becomes office manager of sales.

✦ ✦ ✦

Sidney B. Blaisdell

THE Fidelity Machine Company, 3908-18 Frankford Avenue, Philadelphia, Pa., have appointed Mr. Sidney B. Blaisdell, with offices at 228 Aborn Street, Providence, R. I., as New England sales representative. Mr. Blaisdell, who is a mechanical Engineer, and a graduate



AMF Crawford INDUSTRIAL OVENS

ROD AND WIRE BAKING
ARMATURE AND COIL BAKING
DRYING OF INSULATED WIRE
DRYING OF WIRE SCREEN CLOTH
MELTING OF COMPOUNDS

Ovens — Dryers — Heaters — Tanks — Trucks

ANY FUEL — CONVECTION OR RADIATION HEATING

Our thirty-five years of experience in building any size of Industrial Ovens is at your disposal.

(Write for our new 44 page catalog.)

AMERICAN MACHINE & FOUNDRY CO.
CRAWFORD OVEN DIVISION
200 SHELTON AVE. NEW HAVEN, CONN.

of the Massachusetts Institute of Technology, has been located at the main plant in Philadelphia for the last twelve years and as New England representative is prepared to serve manufacturers in the Knitting, Braiding, Clothing and special textile machine field.

✦ ✦ ✦

Frank B. Williams, Jr.

MR. Frank B. Williams, Jr., has been elected Vice President in charge of the Merchandising Division of the Westinghouse Electric & Manufacturing Company. He assumes charge of the division immediately and will make his headquarters in Mansfield, Ohio. He succeeds Mr. A. E. Allen who, the announcement states, has resigned.

✦ ✦ ✦

IN joining Westinghouse, Mr. Williams leaves the position of Vice President and Sales Manager of the Diehl Manufacturing Company, the electrical division of The Singer Manufacturing Company at Elizabethport, New Jersey.

✦ ✦ ✦

MR. Williams started his industrial career on the test floor of the Diehl Manufacturing Company a few weeks after receiving his degree in electrical engineering from Drexel Institute. By 1915 he had become production manager of the company. In 1918 he joined the sales department of the Western Electric Company. Two years later he was made manager of the power apparatus sales division of its New York district. He later continued in this position with the Graybar Electric Company when that company was formed. In 1927 he returned, as sales manager, to the Diehl Company of which he has been a Vice President since 1930.

✦ ✦ ✦

Frank D. Newbury

MR. Frank D. Newbury has been appointed manager of the New Products Division of the Westinghouse Electric & Manufacturing Company. Mr. George H. Bucher, president of the company, announced his appointment as successor to Herbert Mygatt Wilcox, who died July 28. In addition to this development of activities for Westinghouse in new fields, Mr. Newbury will continue his present duties as Economist for the company.

BORN in Brooklyn, N. Y., and graduated as a mechanical engineer from Cornell University in 1901, Mr. Newbury has occupied a number of positions from apprentice to General Manager of Machinery Engineering design over a period of 30 years. Besides carrying on his engineering design work he edited the Electric Journal when it was established in 1904 and was president of the Electric Club (now the Westinghouse Club) during 1906 and 1907.

✦ ✦ ✦

FROM 1918 to 1930 he was active in the American Institute of Electrical Engineers, as a director from 1918 to 1922 and as a member of the standards committee and rotating machinery committee. He was one of the representatives of the A. I. E. E. on the American Standards Association.

✦ ✦ ✦

IN 1935, Mr. Newbury became assistant to the Vice President, in connection with budgets and other administration problems, and later Economist.

Hubbard Spool Company

Extends Greetings to the Members of the

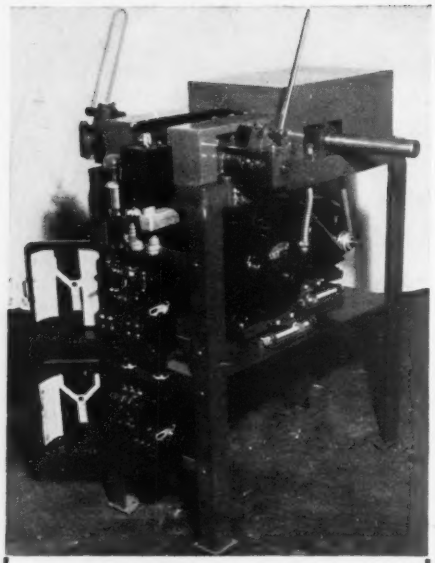
Wire Association

Here's to a Successful Meeting!

Hubbard Spool Company

1622 Carroll Avenue **Chicago, Ill.**

TELEPHONE SEELEY 1214



DAVIS

COMBINED SPARKER
and
COILER
for
INSULATED WIRE

This machine MEASURES, COILS, and SPARK TESTS SIMULTANEOUSLY.

Individually motor-driven coiling heads make possible increased production thru continuous operation.

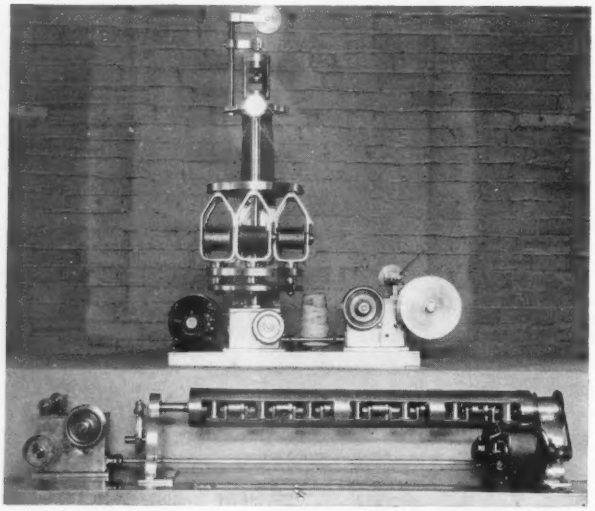
Overages in length are prevented by the electrically operated counter which stops the machine at desired footage.

Resparking in this operation detects mechanical injuries, factory joints, connections, etc.

R. L. Davis Electric Company, Inc.
WALLINGFORD, CONN.

Bethlehem Exhibits Miniature Working Models of High Speed Rope Making Machines

A FEATURE of the Bethlehem Steel Company's exhibits at the Mining Congress in Cincinnati and at the Oil World Show in Tulsa was the miniature model of high speed rope making machines which go one step further than most so-called working models because they actually work. A miniature strander and closer made zinc coated strand and 3/32" wire rope right under the spectators' eyes.



Miniature Rope Making Machine.

✦ ✦ ✦

W. E. SOMERVILLE of Coal City, Ill., who developed the high speed rope machines now employed in the Bethlehem Steel Company's Williamsport Plant built the models as a spare time hobby back in the early nineteen thirties. In order to avoid breakdowns or excessive wear in operation he found it necessary to make many of the parts heavier, such as gears and shafts, than called for in a design carried out exactly to the scale of the larger machines of which they are copies.

✦ ✦ ✦

THE wire employed in the strander is of .010" diameter or at about the size of wire used in house screens or fly swatters. The slender 3/32" rope produced at the exhibits will in effect be of top-notch Bethlehem Purple Strand quality, and will even have the purple strand in it that identifies this brand.

TO WIRE MILL PRODUCTION EXECUTIVES

IF you are making high carbon spring wire and getting less than 6000-9000 lbs. of .076 spring wire .55 carbon per 8 hour shift per man

IF you desire to start the production of high grade carbon spring wire from #8 to #18 gauge

I CAN HELP YOU!

WITH special processes, techniques and materials — Quick Casting = Superior Quality

ALSO spring wire from unpatented rod in #8 to #12 gauge.

For Detailed Information Address Licensed Professional Engineer,
Box 705, c/o Wire & Wire Products,
17 E. 42nd St., NEW YORK, N. Y.

THERE WILL BE A REGISTRATION FEE OF $5.00 FOR THOSE ATTENDING THE WIRE ASSOCIATION TECHNICAL SESSIONS AND INFORMAL MEETINGS ADMISSION WILL BE BY BADGE ONLY

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

WIRE & WIRE PRODUCTS
17 East 42nd Street
New York City

All Aboard FOR DETROIT

OCTOBER 17 ★ 21

Reservations are pouring in. Metal men are coming by train . . . by automobile . . . by bus . . . by plane . . . and by ocean liner . . . the progressive far-sighted men of metal of this and other nations, men who realize that, under today's conditions and in the face of today's competition, no one can know too much about his job and his specialty.

Four great technical societies are co-operating to assure you five days filled to the brim with inspiration, education and stimulating contacts—five days that will re-charge your brain-cells and send you home better equipped to face the problems of the months ahead.

The question isn't—"Can you afford to come" . . . the true question is—"Can you afford not to come" . . . can you risk letting others monopolize the benefits of attendance at the world's greatest annual event in the Metal Industries?

Co-operating societies—American Society for Metals; Wire Association; Institute of Metals Division and Iron and Steel Division of A.I.M.E.; American Welding Society.

•

More than 52 technical sessions with prepared papers and talks by the nation's recognized authorities on the metallurgy, fabrication, treatment, inspection and testing of ferrous and non-ferrous metals.

•

More than 200 carefully developed exhibits by leading manufacturers serving the Metal Industries.

Under the auspices of American Society for Metals, 7016 Euclid Ave., Cleveland, Ohio

NATIONAL METAL EXPOSITION

A New Electro Galvanizing Process

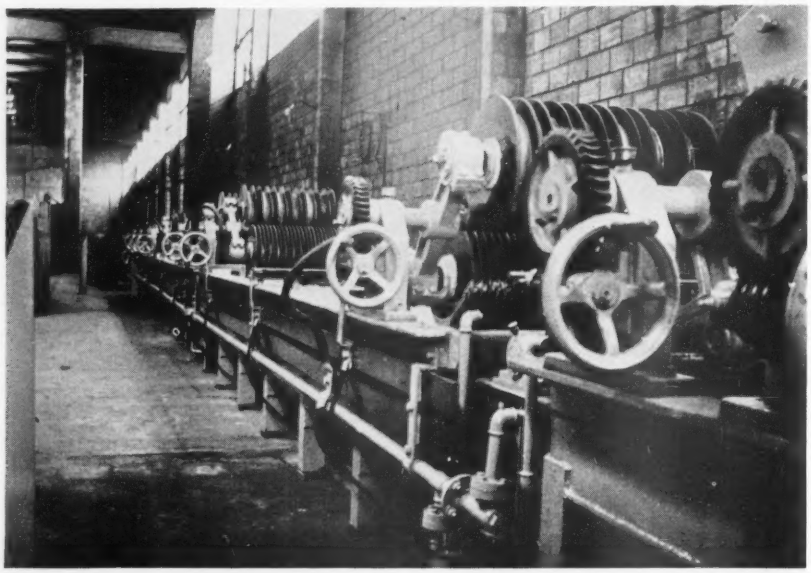
Successful English System is Claimed to be 50% Faster Than Hot Method; Many Advantages Seen

By George D. Hartley

THE Marino galvanizing process, which has had a wholly successful five-year trial in England under rigid mill production conditions, is being offered in the United States and Canada for license or sale through the office of George D. Hartley, Consultant, 311 Main Street, Worcester, Massachusetts. By this process thousands of tons of wire have been produced for the trade in sizes ranging from ½" rods to the finest wires.

✦ ✦ ✦

THIS process, incorporating electro-cleaning, pickling and galvanizing in an entirely automatic process, will cover wires and shapes with tin, lead, copper, brass, nickel, cadmium, or other metals and alloys.



A Marino electro-galvanizing unit in operation in an English plant. Note compactness and cleanliness of this straight-line cleaning, pickling and coating process.

✦ ✦ ✦

PROVEN by production schedules to be 50% faster than hot galvanizing, and by cost sheets to be 40% cheaper, this process is particularly adaptable where rigid specifications are demanded, one mill in England turning out 50 tons of Marino galvanized high tensile wire weekly for British Government agencies. Wires such as are used in rope manufacture, and in the various shapes, are produced in quantity. Increasing demand for the British productions is being expressed by both American and Canadian firms.

✦ ✦ ✦

SINCE no heat is used in the process, the zinc is not oxidized, no dross is formed, the zinc in process is completely utilized, and need not be kept in a molten condition when the mill is closed for week-ends, holidays, or part-time production. The bugbears of fuel, burnt pots and furnaces with associated heat, smoke and dirt are entirely eliminated.

✦ ✦ ✦

A CONCISE list of 10 distinct advantages are given below:

1. 50% faster, 40% cheaper than hot galvanizing.
2. High class, first quality coatings which easily meet all British and American tests and standards.
3. Galvanized coat, thicknesses being equal, stands up better under atmospheric, brine, or acid fume conditions.
4. Wire is not embrittled by acid and heat combination.
5. Wire retains torsions and bends unchanged as is desirable in springs, etc.
6. No losses from oxidization; no dross.

OVER FIFTY YEARS SPECIALIZATION
Is a Guarantee For
WIRE DRAWING DIES

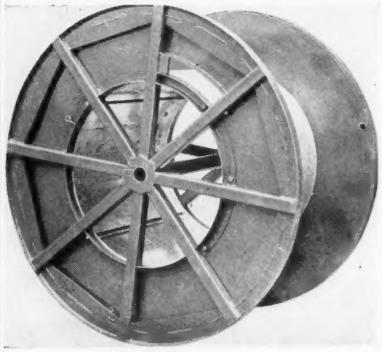
OUR FAMOUS
GLOWIDIE DIES
THE BEST CARBIDE DIES FOR DRAWING, TUBING, SIZING FOR FERROUS AND NON-FERROUS METALS GIVE THE HIGHEST TONNAGES

OUR SUPERIOR
DIAMOND DIES
MADE OF FIRST GRADE BRAZIL STONES FOR EVERY CLASS OF WIRES HIGH SPEED DRAWING DIES WITH THE LATEST IMPROVEMENTS GIVE LONGER LIFE

GLOBE WIRE DIE CO.
(BRANCH OF THE ATELIERS FERRET-GOGLIO, COUZON (HAUTE-MARNE)
DIJON, FRANCE
General Agent—United States & Canada, M. V. DREYSPOOL, 299 Madison Av., New York City, N. Y.

ALL STEEL REELS

FOR SHIPPING
FOR STORING
CABLE AND WIRE



Last Longer

Constructed of corrosion resisting materials, three to four times the life of a wooden reel is a reasonable expectancy.

Give Greater Protection

Smooth inner surfaces, much greater strength with the absence of all cutting or abrading projections — these protect not only the cable but the men handling it.

Save On Freight

Appreciably lighter than wooden reels — cost less to ship — a cumulative saving that more than offsets increased first cost.

Reduce Investment

The longer life of R. B. Hayward Steel reels reduces the investment in reel equipment.

Write for description of construction and prices.

R. B. HAYWARD CO.
1714 Sheffield Ave.
Chicago, Illinois

Manufactured and sold under license arrangements with Western Electric Company, Incorporated.

7. No heat is used; hence fuel, burnt pots and furnaces are eliminated.
8. Process eliminates heat and dirt, smoke and unhealthy conditions.
9. Process tried and proven by five years of actual operation under mill production schedules.
10. Process fully protected by mechanical and chemical patents.

✦ ✦ ✦

MR. HARTLEY, who has been identified with the wire trade for the past twenty-five years, will be glad to answer any of the innumerable questions which may be expected to rise in the minds of American and Canadian wire mill men and will act as Mr. Marino's agent in this country and Canada in the licensing and installation of this process.

✦ ✦ ✦

Washer Firm Publishes New Stock List

THE Wrought Washer Mfg. Co. of Milwaukee, Wis., world's largest producer of washers, expansion plugs, stampings, tools and dies, serving the wire fabricating industry, has announced the publication of a new stock list—No. 55-B—available to wire product manufacturers upon request.

✦ ✦ ✦

THIS new publication lists thousands of washer specifications in various materials, including steel, brass, copper, aluminum, fibre, etc., carried in actual inventory available for immediate shipment. Those sizes permanently maintained in stock are so designated, thus enabling manufacturers to select for standard production as well as new assemblies the particular sizes on which they can always secure prompt delivery.

1938 WIRE AND WIRE PRODUCTS BUYERS GUIDE AND YEAR BOOK OF THE WIRE ASSOCIATION

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✦ ✦ ✦

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Wire & Wire Products

17 E. 42ND. ST.
NEW YORK, N. Y.

A New Fabric Covering for Wire and Cable

IT has been realized for a long time in the textile industry and even among some wire engineers that the knitting method of forming individual strands into a cover for wire and cable had great advantages by the very nature of the process, as opposed to any other method.

✦ ✦ ✦

AS textile engineers confirm, the chief advantage which knitting enjoys is its simplicity and evenness of movement. The basis of the knitting process is nothing more than a rotating cam. Since the cam directly motivates the needles, there is the simplest kind of mechanical operation.

✦ ✦ ✦

FIGURE 1 shows a knitting head for applying a single cover to wire. Small as the unit may seem to those familiar only with other processes, it embodies all the necessary mechanism for the purpose. The grooves shown contain the needles and rotate around a stationary cam in this model. The whole operation is as compact and direct as illustrated.

✦ ✦ ✦

DUE to this evenness and simplicity of operation knitting is about five times as fast as braiding and from that speed, when applied to wire covering, great advantages can be derived.

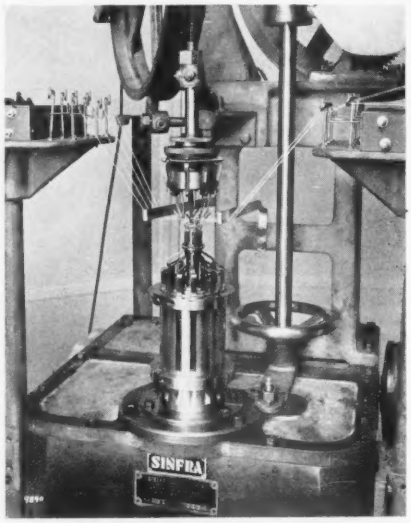
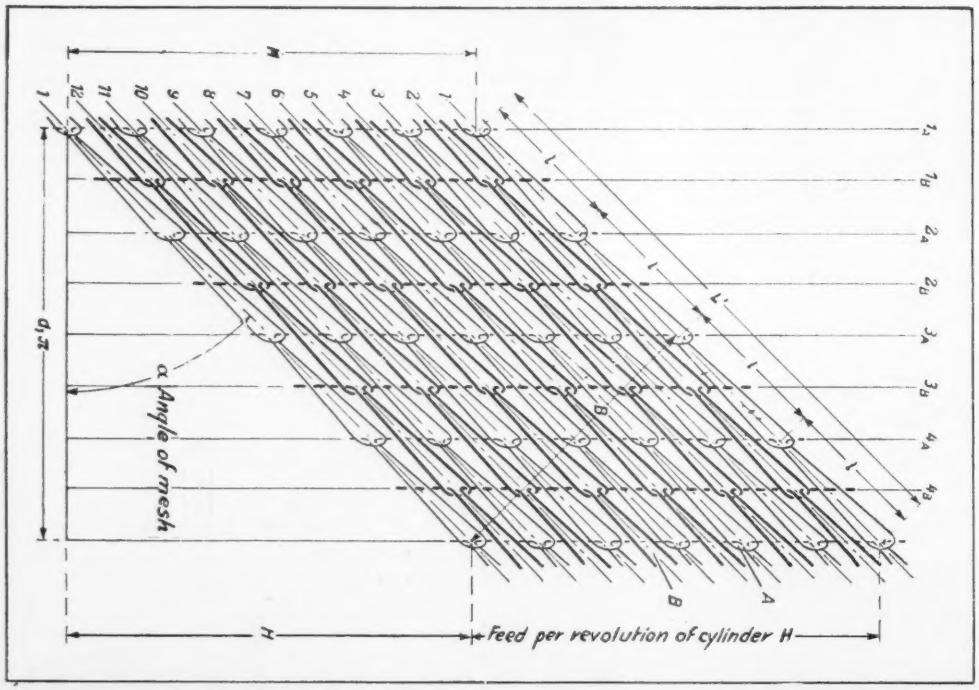


Fig. 1.

✦ ✦ ✦ ✦



WITH one fifth the number of machines to work in order to obtain the same production, a wire manufacturer saves labor and space. Moreover, he saves in initial cost since he needs to buy that many less machines.

✦ ✦ ✦

BUT knitting offers other advantages beside speed. Because the motion is so direct and centralized only a fraction of the power which other processes waste on driving long arms and in indirect motivation is necessary. For the same reason maintenance and repair expenditures are greatly reduced. Then, too, knitting is a silent operation and makes for a very attractive shop.

✦ ✦ ✦

MOST important of all the advantages for knitting, however, is the fact that the bobbins are stationary and their shape or size has no bearing on their use by the machine. This means the elimination of the entire rewinding operation with all its expensive ramifications. The savings effected here alone were enough to recommend knitting to the wire industry.

✦ ✦ ✦

WITH all of these advantages as a goal in mind research has been going on for a good 30 years along the lines of adapting the process to the needs of wire covering, one of the early patents in this direction being dated 1909.

✦ ✦ ✦

A DIFFICULT obstacle, however, was soon discovered in that once the knit cover was applied, the wire could not be bent without breaking the cover. Other problems which naturally appeared with so new a development were never settled since it was obvious that a flexible cover would first have to be dis-

covered before there was any use in continuing the experiments.

✦ ✦ ✦

RECENTLY a means of spiral knitting has been developed which has entirely overcome this trouble and the Sinfra Corporation is now making the machines which embody this patented principle. The sinfranized cover offers an actual advantage in that the spiralled stitches provide great flexibility and the cover cannot burst when turned or twisted.

✦ ✦ ✦

ALSO in other than the burst test the sinfranized cover has been found to be approximately equivalent to the braided cover. Moisture absorption tests, flame tests, abrasion tests and installation tests have all been made on a comparative basis to braid with favorable results.

✦ ✦ ✦

IT is found that the same weight of cotton per length of conductor is applied by sinfranizing as by braiding. A saving in cotton can be effected by this process but generally the amount of cotton is specified so that no very great change is usually made in that direction by the manufacturers who use Sinfra machines.

✦ ✦ ✦

THE thickness of the covering complies with the Underwriters standard for rubber covered wires and the thread pattern is such that excellent results are obtained in impregnating both triple covered weatherproof as well as ordinary code wire.

✦ ✦ ✦

SINFRANIZING can be done with virtually any thread now in use for wire and cable between No. 6 and No. 22 AWG, which is the range of accommodation for Sinfra machines as presently constructed. New designs in the cover can be made with different colored yarns which has also proven to be of quite some interest.

✦ ✦ ✦

THE composition of the sinfranized cover is illustrated below in Figure 2. It consists of two intertwined single knitted covers. The stitches of the first covering cover the connecting yarn of the second covering and vice versa.

✦ ✦ ✦

EACH individual covering is composed of four yarns equally spread over its circumference and symmetrically arranged between these four are the four yarns of the second covering. These eight yarns together form one complete covering.

✦ ✦ ✦

IN the illustration the covers are marked "A" and "B" so that the complete construction can be made out by following threads 1A, 2A, 3A and 4A and likewise threads 1B, 2B, 3B and 4B.

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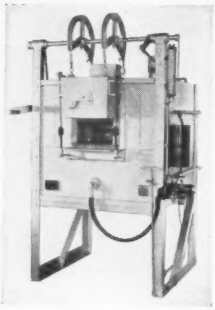
Hayes Wins Patent Suit

The Hayes patents covering "Certain Curtain" control have recently been sustained by the Circuit Court of Appeals, the final decree enjoining Surface Combustion Corporation from further infringement.



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- The Duriron Company has specialized for over 25 years in making equipment for corrosive liquids exclusively. The technical knowledge and practical skill thus gained is available to you in the application of Duriron Company's products to your case.

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445 N. Findlay St. Dayton, Ohio

Gloves for Wire Drawers

WORKMEN don't like to use gloves. And, they don't use them unless the operation they are performing is much too severe for bare hands. So, gloves are only utilized on the tough jobs where anything that could be used would receive a great deal of punishment. This situation has created the axiom "work gloves don't last very long."

✦ ✦ ✦

AN industrial operation requiring the use of gloves is illustrated in the plant of Midland Wire Corp. The operation consists of drawing copper rod through dies of smaller and smaller diameter until the correct size is reached. The wire runs through a lubricating mixture of grease and soap before going through the die. Gloves are a necessity as the operator guides the wire with his hands when he starts and stops the machine, and it will burn his hands if they are not protected. Ordinary canvas gloves last barely one day, since the moving wire rapidly abrades the fabric.

✦ ✦ ✦

A PAIR of gloves per day per workman is a considerable item of expense. Naturally, the wire manufacturer made a thorough investigation in an effort to obtain a more economical glove. He tried canvas gloves coated with rubber, but the rubber was quickly disintegrated by contact with the grease. It softened and peeled readily. Leather gloves proved little better. Finally, the manufacturer tried canvas gloves impregnated with neoprene and found the answer to his problem. The neoprene gloves are giving an average of four and one-half days service. In addition, with these gloves the workmen are able to keep their hands clean where as with canvas and leather gloves the lubricant soon soaked through. The slippery, gripping surface so formed was so bad that tools were held with difficulty.

MAKE YOUR PLANS NOW TO COME TO THE WIRE ASSOCIATION MEETING

The Kind and Necessity of Tests For Rope Wire

(*Continued from Page 555*)

nection with the research and investigations being carried on to produce better wire.

✦ ✦ ✦

NO single test will tell the complete story of wire quality, but all tests must be correlated, with consideration given as to what effect one characteristic has upon the others, and with due regard as to the significance of each test in reflecting the desired properties.

✦ ✦ ✦

WHEN the difficulty, or rather the impossibility of duplicating in the laboratory the actual field conditions under which wire rope operates is considered, it is apparent that the controlling factor of wire rope quality, insofar as wire is concerned, still depends upon the control and testing of the individual wires composing it.

✦ ✦ ✦

Westinghouse Rectox Rectifier

TO counteract and practically eliminate galvanic action or electrolysis of underground pipe lines, cables, etc., a copper-oxide rectox rectifier developed for cathodic protection has just been announced by Westinghouse Electric & Mfg. Co.

✦ ✦ ✦

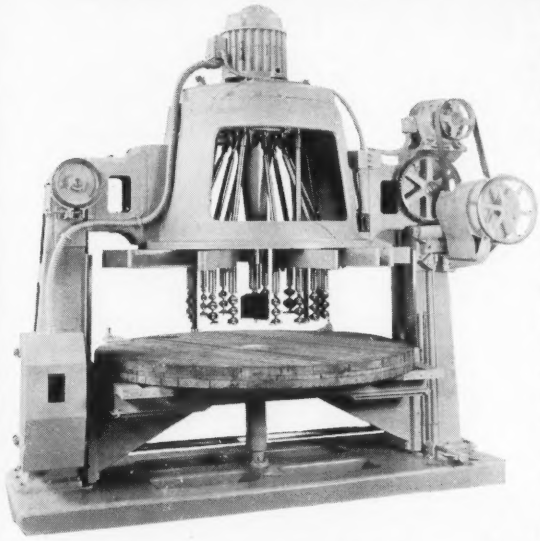
THESE rectifiers have a rating range from 3 to 50 volts, 1 to 125 amperes D. C. output. They consist of the necessary rectox units for the desired rating, together with a two-winding transformer, disconnect switch, and terminal board, all mounted on sheet steel ventilated cabinet designed in some cases for outdoor use and in others for indoor use.

✦ ✦ ✦

American Steel & Wire Reaffirms Its Prices for the Fourth Quarter

THE American Steel & Wire Company, subsidiary of the United States Steel Corporation, has announced that prices on rods, wire, wire products, and cold rolled strip have been reaffirmed for the fourth quarter.

ROOT Style "AMRH" REEL Borer



The reel borer shown on cut was equipped to bore thirteen 2½" holes and one 6¾" diameter hole through 3" thick reel head. Boring time 28 seconds. This statement is evidence of the size, power and efficiency of the machine.

The Root Double Column Style "AMRH" will handle wooden reel heads up to 100" diameter.

The Root Single Column Style "AMH" Reel Borer will handle wooden reel heads up to 42" diameter.

Send blue prints or sketches showing location of holes in large and small reel heads for our recommendation of the style machine best adapted for your job.

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Construction Starts on New Carboloy Detroit Plant

CONSTRUCTION of a new Detroit factory and general offices for Carboloy Company, Inc., manufacturers of cemented carbide tools and dies, was started August 10, it was announced by the company.

✦ ✦ ✦

THE new plant, costing about $700,000.00 and to be located on the north side of Eight Mile Road one half mile east of Van Dyke, will bring under one roof the entire manufacturing facilities of several plants now located at Cleveland, Ohio; Stamford, Connecticut and Detroit, Michigan. At present, the initial manufacturing process is performed principally in Cleveland, while the succeeding steps, incorporating these blanks and nibs into tools and wire drawing dies, are divided between the Stamford, Connecticut, and Detroit plants. In the new plant the complete manufacturing cycle on all Carboloy products will be carried on under one roof. The new quarters, designed by Smith-Hinchman and Grylls, Detroit, architects, is being constructed by O. W. Burke Company, Detroit, Michigan, under the supervision of the General Electric Realty Corporation. The structure will be in two units, having a total area of 121,222 square feet. Manufacturing facilities and research laboratories will be accommodated in a one story building containing 87,122 square feet of floor space. The general administration offices, consisting of a two-story building with an area of 34,100 square feet will face Eight Mile Road immediately in front of the factory buildings. Ample room for further expansion is provided as the new site is located on a 40-acre tract of land.

The New Detroit Plant of The Carboloy Company.

✦ ✦ ✦

ACCORDING to W. G. Robbins, President of Carboloy Company, the plant will be ready for occupancy about January 1, 1939. Approximately 500 persons will be employed when the organization is operating at full capacity.

✦ ✦ ✦

COMPLETE details of the manufacturing facilities to be provided are not available as yet. However, the new plant is said to provide the largest cemented carbide manufacturing capacity in this country and is so designed that the original facilities can be further increased if necessary.

EVERY provision is said to have been made for producing cemented carbides in the most efficient, economical manner possible. Some indication of the extent to which this will be accomplished is evidenced in the fact that provision has been made for catching and utilizing even the rain water as a source of water supply for all manufacturing requirements. Other features include a complete plant for producing high quality hydrogen for use in all brazing and sintering furnaces; dust-sealed, air-conditioned quarters to provide proper facilities for processing the raw materials used in Carboloy, and air-conditioned offices.

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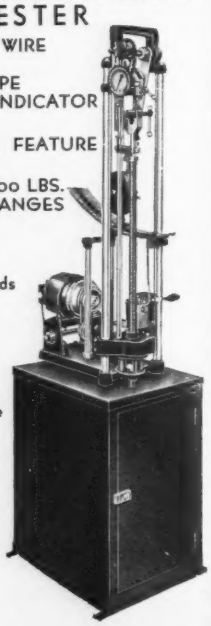

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Bridgeport Brass Co. Completes Plant

THE Bridgeport Brass Company announces the completion of a new manufacturing plant at Bridgeport, Conn., for the production of brass, copper and copper-base alloys for industrial and commercial use, marking the largest expansion and modernization program undertaken in the non-ferrous metals industry since 1929.

✦ ✦ ✦

THE plant has a total floor area of more than 220,000 square feet, making it the largest single unit of the thirty-four major buildings maintained by the company in Bridgeport. It utilizes the straight-line production principle for the first time in the industry. The new mill will have a productive capacity of more than 6,000,000 pounds of metal per month.

✦ ✦ ✦

IN addition to the new manufacturing plant the company has completed a new mill office and laboratory building, the whole development being located on a nine-acre plot.

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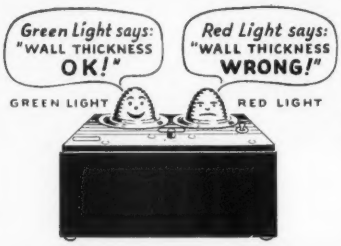

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Comtor "Watchman"

Gives you the full benefit of your coating gage, because it flashes to an observer at a distance the news of whether the thickness is within the proper limits.

Request new Bulletin 26

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Last Longer

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Remember Premier Diamond Dies last longer because the weight of the stone permits the maximum of recutting.

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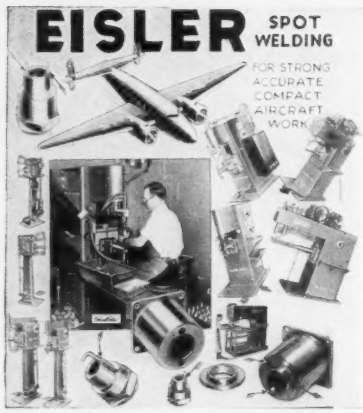

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Coming Problems Created by the Fair Labor Standards Act of 1938

A NEW wave of wage demands and an acceleration of technological advance appear to be the probable consequences of the Federal wage-hour law, in the opinion of business economists Allen W. Rucker and N. W. Pickering. A preliminary study of this law, released by Farrel-Birmingham Company, Inc., Ansonia, Connecticut, under the title of "Coming Problems Created by The Fair Labor Standards Act of 1938," summarizes the findings of Messrs. **Rucker and Pickering.**

✦ ✦ ✦

"THE outcome most likely is an accentuation of the shift or 'economic drift' of the normal distribution of the total wage fund of manufacturing industry. The prevailing drift is away from heavy industry. For instance, in 1929 labor in heavy industry received 59.48% of the total manufacturing wage fund; labor in light industry received 40.33%. In 1935 heavy industry labor received only 50.58% and light industry labor 49.14%. It is difficult to avoid the conclusion that stresses set up by this shift will appear in the form of renewed demand for wage increases, as heavy industry labor seeks to counterbalance the shrinkage in the wage fund by higher rates of pay."

✦ ✦ ✦

ACCORDING to the **Rucker** and **Pickering** study, both the annual manufacturing wage fund and the annual manufacturing income fund are limited by external forces and neither can be expanded beyond the limits imposed by those forces. For that reason the attempt of the Federal government to raise the income of labor in some industries will be followed by corresponding reductions in the wage income of labor in other industries. The pressure, in the view of the authors, is likely to fall heaviest upon the highly skilled crafts and upon the heavy industries.

✦ ✦ ✦

AS an illustration, the Iron and Steel Industry group suffered a contraction in its wage fund from 12.3% of the national wage fund in

1929 to 11.6% in 1935, a reduction equal in 1935 to $52.8 millions or 6%. Reductions of this magnitude, according to Messrs. **Rucker** and **Pickering,** virtually compel industry to seek lower wage costs by mechanization and reduced rates while at the same time impelling labor to seek higher pay rates and means of sustaining employment.

✦ ✦ ✦

New Bulletin of American Insulating Machinery Co.

A NEW Bulletin Form 77-B-3, illustrating and describing various types of the #2 machine with a range of wire from #15 to #25 B. & S. Gauge (.057″ to .018″) has just been issued by the American Insulating Machinery Company of Philadelphia, Pennsylvania.

✦ ✦ ✦

THE Bulletin is interesting in that it presents a variety of constructions built in accordance with customers' specifications, and particular attention is called to their Insulation Winding Machine, with each unit individually motor driven, and to the individual saturating tanks adapted to these machines.

✦ ✦ ✦

COPIES of the Bulletin can be obtained by writing the American Insulating Machinery Company, Fairhill and Huntingdon Streets, Philadelphia, Pennsylvania.

✦ ✦ ✦

Glass Material Covers Magnet Wire

DESCRIBED by its manufacturers as the first inorganic textile, a new material made of glass is used by Anaconda Wire & Cable Co., New York, in covering magnet wire and coils.

✦ ✦ ✦

IN appearance insulation resembles silk. Its dielectric strength and insulation resistance are high and not seriously affected by high temperature or high relative humidity. Insulation is mechanically strong and wires can be wound into coils by same methods used for other magnet wires. Space occupied by this type of wire is less than that needed for double cotton of same gage.

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Statement of Ownership

Statement of ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912 and March 3, 1933, of Wire & Wire Products published monthly at Washington, N. J., for October 1, 1938.

State of New York, County of New York, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared Richard E. Brown, who, having been duly sworn according to law, deposes and says that he is the Editor of Wire & Wire Products and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Quinn-Brown Publishing Corporation, 17 East 42nd St., N. Y. City; editor, Richard E. Brown, 17 East 42nd St., N. Y. City; managing editor, none; business manager, R. S. Spengel, 17 East 42nd St., N. Y. City.

2. That the owner is: (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Quinn-Brown Publishing Corporation, 17 East 42nd St., New York City, and Leta B. Brown, of 17 East 42nd St., New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding one per cent of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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(President)

Sworn to and subscribed before me this 2nd day of September, 1938.

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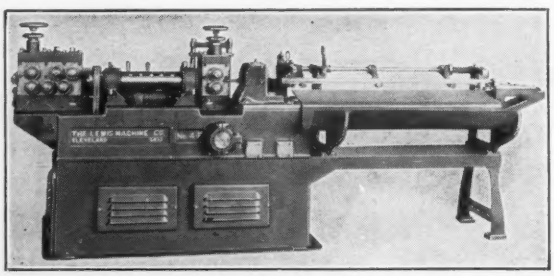

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New Method of Liquid Carburizing

CHAPMAN Valve Mfg. Co., Indian Orchard, Mass., recently announced the development of a new method of liquid carburizing. It is called Valcase and uses a fused salt bath mixture readily melted in ordinary pot furnaces without excessive fuming or smoking. This bath is said to be a true carburizing bath especially suitable for maximum penetration in minimum time. One advantage claimed for the new method is that parts, when withdrawn from the bath without quenching, may be readily machined, then reheated and quenched. Other advantages claimed include uniform depth and hardness of case, rapidity of penetration, freedom from corrosion of finished parts, fluidity of the bath at operating temperature reducing "drag out" loss, high impact and wear resistance values, gradual merging of case with core, and no pitting or decarburization.

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✦ ✦ ✦

THESE rectifiers have a rating range from 3 to 50 volts, 1 to 125 amperes d-c. output. They consist of the necessary rectox units for the desired rating, together with a two-winding transformer, disconnect switch, and terminal board, all mounted on sheet steel ventilated cabinet designed in some cases for outdoor use and in others for indoor use.

✦ ✦ ✦

HOW much current and voltage is needed to protect a given length of pipe line can only be found out by actual trial, due to the variation in resistivity of coating and of soil condition already mentioned. Usually it has been found that if the pipe can be maintained negative to the earth by 0.3 volts or more, corrosion will be stopped.

✦ ✦ ✦

THE Rectox Copper-Oxide rectifier requires no maintenance as there is nothing to wear out and no attention beyond the occasional check of output which is required anyway due to the seasonal variations in soil and coating resistivity. The Rectox can be mounted in a weather-proof cabinet permitting pole mounting if desired along the right-of-way.

✦ ✦ ✦

IT has no rotating parts and operates entirely without noise. An extremely important characteristic is that it operates without causing radio interference.

✦ ✦ ✦

Air Circulator Blades

LATEST contribution of the Torrington Manufacturing Company to the field of air impellers is the addition of a 20" blade to its well-known AIRISTOCRAT line. Of handsome and modern design, this blade produces at recommended speeds a high velocity air stream effecting deep penetration with unusual quietness. A 30" size will also be marketed soon. The Company claims that this is not "just another fan blade," but is the result of two years of laboratory research and experiment to produce better blades for this rapidly expanding field, particular attention having been given to public demand for a lower noise level. Bulletin No. 1538 gives complete specifications for two blade pitches in both the 20" and 24" sizes, including guaranteed ratings in curve form showing air deliveries and power requirements within the range of recommended speeds. The Company's well-known ARISTOCRAT line of fans now includes sizes 8" - 10" - 12" - 14" - 16" - 18" - 20" - 24"—and will soon include a 30" size. These will be followed with 36", 42" and 48" sizes.

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At DETROIT, MICH. OCTOBER 17th to 21st, 1938

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Norton Co., Worcester, Mass.

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Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.

ANODES—Nickel
Seymour Mfg. Co., Seymour, Conn.

ANTI-RUST—
Magnus Chemical Co., Garwood, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Worcester, Mass.
Watson Machine Co., Paterson, N. J.

BAKERS—Rod and Wire
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.
Morgan Construction Co., Worcester, Mass.
Morrison Engineering Co., Cleveland, O.

BORER—Reel
Root, B. M., York, Pa.

BORON CARBIDE—
Norton Co., Worcester, Mass.

CARRIERS—High Speed Braider
Apco Mossberg, Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

CEMENT FLOOR CLEANER—
Magnus Chemical Co., Garwood, N. J.

CEMENTS—Refractory
Norton Co., Worcester, Mass.

CHEMICALS—Cleaning
American Chemical Paint Co., Ambler, Pa.
Magnus Chemical Co., Garwood, N. J.
Parkin Co., The Wm., Pittsburgh, Pa.

CLEANERS—Hand and Metal
Magnus Chemical Co., Garwood, N. J.

CLEANING & PICKLING EQUIPMENT—
Broden Construction Co., Cleveland, O.
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.
Morgan Construction Co., Worcester, Mass.
Nukem Products Corp., Buffalo, N. Y.
Vaughn Machinery Co., Cuyahoga Falls, O.

COATING—Protective
American Lanolin Corp., Lawrence, Mass.

COILERS—Sheet, Strip and Wire
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

COLD HEADERS—
Ajax Manufacturing Co., Cleveland, O.
National Machinery Co., Tiffin, O.

CONDUITS—Iron and Steel
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONTROLS—Automatic
Leeds & Northrup Co., Philadelphia, Pa.

COPPER—Electrolytic
U. S. Metals Refining Corp., New York, N. Y.

CRANES—Wire Mill
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

DIAMOND TOOLS—
Rusch Wire Die Corp., New York, N. Y.

DIES—Diamond
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Cochaud Wire Die Co., New York, N. Y.
Driver-Harris Co., Harrison, N. J.
Globe Wire Die Co., (M. V. Dreyspool) New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Lead Extrusion
John Robertson Co., Brooklyn, N. Y.

DIES—Repairs & Re-Cutting
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Cochaud Wire Die Co., New York, N. Y.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Rod and Tube Drawing
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Globe Wire Die Co., (M. V. Dreyspool) New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Tantalum Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Tungsten Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Globe Wire Die Co., (M. V. Dreyspool) New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, O.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

ENGINEERS—Consulting Wire Mill
Lewis, Kenneth B., New York, N. Y.
Hartley, George D., Worcester, Mass.

EQUIPMENT—Insulation Testing
Davis, R. L., Co., Wallingford, Conn.
Leeds & Northrup Co., Philadelphia, Pa.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FILLERS—Paper for Cable
E. W. Twitchell, Inc., Phila., Pa.

FLASH BAKERS—
Morrison Engineering Co., Cleveland, O.

FURNACE CONTROLS — Combustion
Leeds & Northrup Co., Philadelphia, Pa.

FURNACE CONTROLS—Draft
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Annealing
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Leeds & Northrup Co., Philadelphia, Pa.
Rockwell, W. S., Co., New York, N. Y.

FURNACES—Automatic
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Leeds & Northrup Co., Philadelphia, Pa.
Rockwell, W. S., Co., New York, N. Y.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, O.
Hayes, C. I., Inc., Providence, R. I.
Lee Wilson Engineering Co., Cleveland, Ohio
Rockwell, W. S., Co., New York, N. Y.

FURNACES—Electric
Electric Furnace Co., Salem, O.
Hayes, C. I., Inc., Providence, R. I.
Rockwell, W. S., Co., New York, N. Y.

FURNACES—Galvanizing
Lee Wilson Engineering Co., Cleveland, Ohio

FURNACES—Hardening and Tempering
Electric Furnace Co., Salem, O.
Hayes, C. I., Inc., Providence, R. I.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Lead Melting
Electric Furnace Co., Salem, O.
John Robertson Co., Brooklyn, N. Y.

FURNACES—Non-Oxidizing
Electric Furnace Co., Salem, O.

FURNACES—Normalizing
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.
Rockwell, W. S., Co., New York, N. Y.

FURNACES—Wire, Strip & Sheet
Electric Furnace Co., Salem, O.
Rockwell, W. S., Co., New York, N. Y.

GALVANIZING EQUIPMENT—
Lee Wilson Engineering Co., Cleveland, Ohio
Meaker Co., The, Chicago, Ill.

GEARS—Wire Mill
Farrel-Birmingham Co., Ansonia, Conn.

GRINDERS—ROLL
Farrel-Birmingham Co., Ansonia, Conn.
Norton Co., Worcester, Mass.

HOISTS—Electric Travelling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.
Parkin Co., The Wm., Pittsburgh, Pa.

INSTRUMENTS—Electrical
The Comtor Co., Waltham, Mass.
Leeds & Northrup Co., Philadelphia, Pa.

INSULATION — Cable or Cable Filler
E. W. Twitchell, Inc., Phila., Pa.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O

LIME—Pulverized
Warner Co., Bellefonte, Ohio.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Ironsides Co., The, Columbus, O.
Magnus Chemical Co., Garwood, N. J.

LUBRICANTS—Wire Drawing
Ironsides Co., Indianapolis, Ind.
Magnus Chemical Co., Garwood, N. J.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.
John Robertson Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Hayes, C. I., Inc., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

WHERE TO BUY, Continued

MACHINERY—Closing
New England Butt Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, O.
Elevator Supplies Co., Inc., Rahway, N. J.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cold Heading
National Machinery Co., Tiffin, O.

MACHINERY—Cold Heading With Wire Drawing Attachment
Ajax Manufacturing Co., Cleveland, O.

MACHINERY—Copper Wire Drawing and Rolling
Elevator Supplies Co., Inc., Rahway, N. J.
Farrel-Birmingham Co., Ansonia, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Covering Wire
Sinfra Corp., Jersey City, N. J.
Syncro Machine Co., Newark, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange, New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
F. B. Shuster Co., New Haven, Conn.
W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.

MACHINERY—Extruding
John Robertson Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Forming
National Machinery Exchange, New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing
Lee Wilson Engineering Co., Cleveland, Ohio

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, O.
Meaker Co., The, Chicago, Ill.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
H. J. Ruesch Machine Co., Newark, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sinfra Corporation, Jersey City, N. J.
Syncro Machine Co., Newark, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Sinfra Corporation, Jersey City, N. J.

MACHINERY—Lead Encasing Presses, etc.
John Robertson Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
John Robertson Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Magnet Wire
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Material Handling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MACHINERY — Measuring Wire & Cable
The Comtor Co., Waltham, Mass.
Davis, R. L., Electric Corp., Wallingford, Conn.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works Co., Chicago, Ill.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.

MACHINERY—Paper Covering Wire
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Pointing
Broden Construction Co., Cleveland, O.
Elevator Supplies Co., Inc., Rahway, N. J.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, O.
Elevator Supplies Co., Inc., Rahway, N. J.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Rubber Strip Covering
Farrel-Birmingham Co., Ansonia, Conn.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
Farrel-Birmingham Co., Ansonia, Conn.
New England Butt Co., Providence, R. I.
Royle, John, & Sons., Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY— Special — Combination Machine for Drawing, Cutting-to-length, Straightening and Reeling Bars from Coil in One Operation (Shumag Type)—
W. A. Schuyler, New York, N. Y.

MACHINERY—Spooling
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange, New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.
F. B. Shuster, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Stranding
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
Elevator Supplies Co., Inc., Rahway, N. J.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing Size of Wire
Davis, R. L., Co., Wallingford, Conn.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Testing Thickness of Wire
The Comtor Co., Waltham, Mass.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
F. B. Shuster Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
Aetna-Standard Engineering Co., Youngstown, O.
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Elevator Supplies Co., Inc., Rahway, N. J.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.

WHERE TO BUY, Continued

W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y. Co., Phila., Pa.
Elevator Supplies Co., Inc., Rahway, N. J.
New England Butt Co., Providence, R. I.

MACHINERY—Wrapping Wire
W. A. Schuyler, New York, N. Y.
Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MILLS—Tandem Rolling and Edging
Torrington Mfg. Co., The, Torrington. Conn.

MOTORS—Electric
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

OVENS—Brazing
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.
Hayes, C. I., Inc., Providence, R. I.

Ovens for All Purposes in the Wire Industry
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.

PAPER—Insulating
Freydberg Bros., Inc., Stamford, Conn.
E. W. Twitchell, Inc., Phila., Pa.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS
American Chemical Paint Co., Ambler, Pa.
Parkin Co., The Wm., Pittsburgh, Pa.

PIPING AND FITTINGS—Acid Resistant
Duriron Co., Inc., The, Dayton, O.
Haveg Corp., Newark, Del.

POTS—Lead Melting
Farrel-Birmingham Co., Ansonia, Conn.
John Robertson Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Farrel-Birmingham Co., Ansonia, Conn.
John Robertson Co., Brooklyn, N. Y.

PRESSES—Lead
John Robertson Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
John Robertson Co., Brooklyn, N. Y.

PYROMETERS—
Leeds & Northrup Co., Philadelphia, Pa.

RECORDERS—
Leeds & Northrup Co., Philadelphia, Pa.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

REEL BORERS—
Root, B. M., Co., York, Pa.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
American Pulley Co., Philadelphia, Pa.
Apco Mossberg, Corp., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Steel
American Pulley Co., Philadelphia, Pa.
Apco Mossberg, Corp., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS AND SPOOLS—Shipping and Shop
American Pulley Co., Philadelphia, Pa.
Apco Mossberg, Corp., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS—
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.
Morrison Engineering Co., Cleveland, O.

RODS—Wire—Steel
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Keystone Steel & Wire Co., Peoria, Ill.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.
Wheeling Steel Corp., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

ROLLS—
Farrel-Birmingham Co., Ansonia, Conn.

RUST PROOF COMPOUND—
American Lanolin Co., Lawrence, Mass.

SHEET—Steel
Continental Steel Corp., Kokomo, Ind.,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.
Wheeling Steel Corp., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Ironsides Co., The, Indianapolis, Ind.
Magnus Chemical Co., Garwood, N. J.

STAMPINGS—
Wrought Washer Mfg. Co., Milwaukee, Wis.

SPOOLS—Steel
American Pulley Co., Philadelphia, Pa.
Apco Mossberg, Corp., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

STRIP—Brass and Non Ferrous
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Haveg Corp., Newark, Del.

TESTING INSTRUMENTS—
Amthor Testing Inst. Co., Brooklyn, N. Y
The Comtor Co., Waltham, Mass.
Scott, Henry L. Co., Providence, R. I.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

TREADS—Safety
Norton Co., Worcester, Mass.

TRUCKS—
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TAPES—Cellophane Marker
Freydberg Bros., Inc., Stamford, Conn.

TUBE BENDERS AND FORMERS—
H. J. Ruesch Machine Co., Newark, N. J.

TURKS HEAD—
Standard Machinery Co., Providence, R. I.

VALVES AND FITTINGS—Acid Proof
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y. Co., Phila., Pa.

WASHERS AND STAMPINGS—
Wrought Washer Mfg. Co., Milwaukee, Wis.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.
Wheeling Steel Corp., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Electric
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Enameled For Coils
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.
Wheeling Steel Corp., Wheeling, W. Va.
Wickwire Bros., Cortland, N. Y.
Wickwire Spencer Steel Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Nickel Silver and Phosphor Bronze
American Brass Co., New York, N. Y.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Non Ferrous to Specification For Special Purposes
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Spring
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Seymour Mfg. Co., Seymour, Conn.
Wickwire Spencer Steel Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Steel—Also Coppered Steel——Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, O.
Wheeling Steel Corp., Wheeling, W. Va
Wickwire Bros., Cortland, N. Y.
Wickwire Spencer Steel Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE AND STRIP—Zinc
Metal Industry Works, Poland.
Platt Bros. & Co., The Waterbury, Conn.

WIRE—Weaving—Non-ferrous
American Brass Co., Waterbury, Conn.

- Consider the common sense features of Morgan-Connor High Block design:

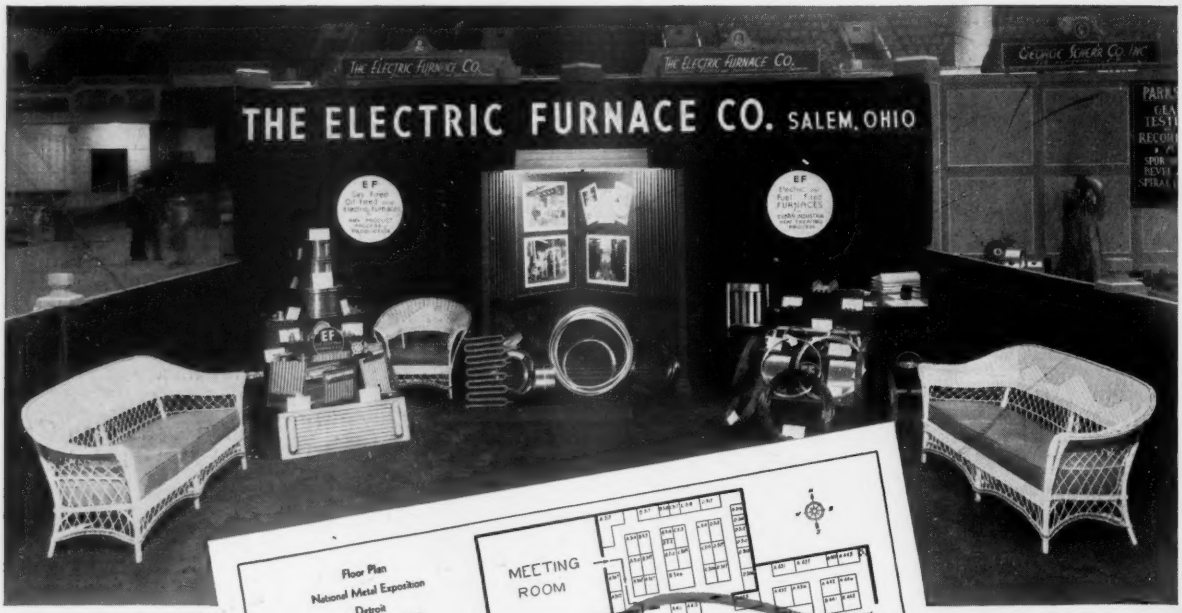
1. Wire is under tension only between dies and blocks — a span of a few inches. Danger of broken wire "whipping" reduced to minimum.
2. Air cooling of wire on high blocks permits greater draft speeds, an important factor in the drawing of high-carbon stock.
3. Individual block storage and control means uninterrupted production.
4. Adequate safety facilities.

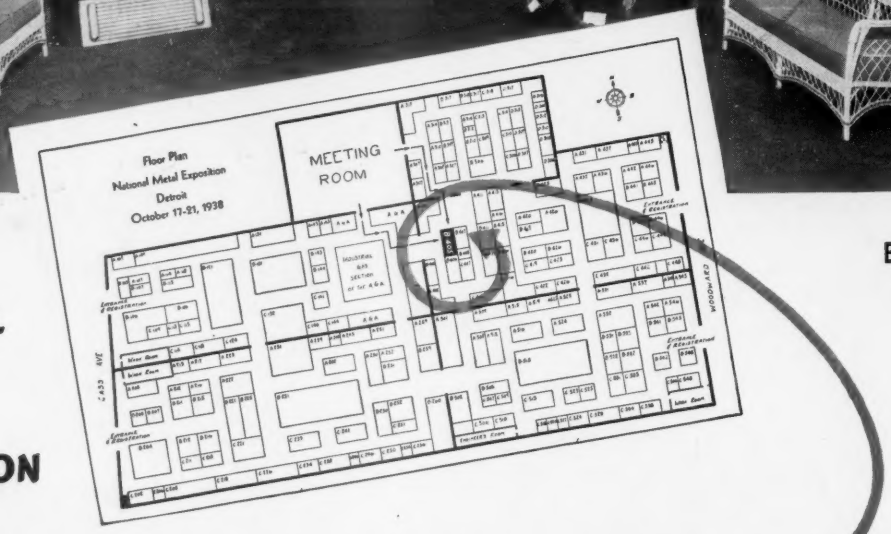
Morgan Construction Co.
Worcester, Mass.

MORGAN-CONNOR

Continuous Wire Drawing Machinery

Sole European Representatives — Malmedie & Co., Dusseldorf, Germany





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We extend to you a cordial invitation to visit our Booth—No. B-405, at the National Metal Exposition, Detroit, October 17th to 21st, - - - to look over the large display of enlarged photographs of outstanding electric and fuel fired furnace installations.

See the latest developments in special atmosphere equipment for bright and clean annealing various ferrous and non-ferrous products, including wire, tubing, strip, stampings and other finished and unfinished products.

See the new continuous furnaces for copper brazing and scale-free heat treating as well as other furnaces of various types for normalizing, annealing, nitriding, carburizing, short cycle malleabilizing, forging, billet heating and other heating and heat treating processes.

See the Elfurno generators for producing the special, inexpensive, protective atmospheres used in controlled atmosphere furnaces.

Investigate the advantages of our new gas-fired recuperative type radiant tubes—the most uniform and the most economically operated gas-fired radiant tube yet developed.

See the heavy cast metallic grid type heating elements—the heaviest and most rugged heating element used in industrial furnace heating.

Inspect the large display of bright annealed, copper brazed and scale-free hardened samples, as well as samples of other products processed in our furnaces.

Our engineers will be pleased to show you the above — and in the meantime, if you have a furnace or heat treating problem they will be glad to discuss that, too.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production